THE BOOK OF FORESTRY

Courtesy U. S. Forest Service

FOREST SCENE, SOUTHERN APPALACHIANS

Who can overestimate the value of a nation's forests? They supply timber, control the run-off of spring flood waters, temper the climate and in countless ways add immeasurably to the comfort and happiness of the people. In the words of John Muir, "They are truly fountains of life."

THE BOOK OF FORESTRY

BY

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WITH MANY ILLUSTRATIONS

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TO

YOUNG AMERICA

AND

TO

DANIEL CARTER BEARD

NATIONAL SCOUT COMMISSIONER

WHO HAS DONE SO MUCH TOWARD MOULDING THE MIND OF THE CITIZEN OF TO-MORROW, THIS BOOK IS RESPECTFULLY DEDICATED

PREFACE

The American people are by inheritance a nation of forest butchers.

Possessing a continent originally endowed with superb forests, unequalled in any part of the globe, the three hundred years which have passed since the Colonists landed upon the Atlantic Coast have seen the area of our forests diminished by 300,000,000 acres, while the contents have been reduced to less than half.

To the early settlers, the forest was a continuous menace. Its growth covered the land needed for the maize fields; Indians and wild beasts of equal ferocity were harbored in its depths, and it is not surprising that our forefathers cleared off the forests ruthlessly, especially since they believed their supply of timber endless.

The wide-awake American citizen of today knows otherwise. He has seen game like the buffalo and the carrier pigeon, considered inexhaustible, vanish before the relentless pursuit of the American hunter. He has seen the splendid stores of coal, iron, and gas enormously reduced within practically a single generation. He knows, if he stops to think about it, that any natural resource can be used up, and that the end of the virgin forests is already in sight. The trouble is that many do not stop to think.

We have so long heard of the richness of our continent, and the variety of our resources that we have considered talk of economy beneath us. However, it is high time that patriotic citizens consider the question

of conservation of forests, waters, minerals, because true patriotism demands that the next generation be given not only the liberties which we have inherited from our forefathers, but also their share of the wealth, with which this country was originally endowed.

It is indeed time that knowledge of and interest in our land and forest problem became more common, and the best way to reach the citizen of tomorrow is to interest and instruct the boy of today. He should be told that forestry is absolutely necessary, not only because we cannot get along without timber, but also because we must make our vast areas of non-agricultural land productive; and because the indirect influences of the forest in controlling floods, in moderating climate, in serving as recreation grounds, etc., are so extremely important.

Forestry means using our forests—not locking them up, and every American, young or old, should realize that our nation cannot long prosper unless it profits by the example of other countries, and cares for its non-agricultural, as well as for its fertile, land.

There are a variety of ways in which popular instruction may be given. The United States Forest Service publishes popular, as well as technical, bulletins, and many States publish circulars on forestry couched in simple terms. However, the outlook for converting the next generation while still at an impressionable age seems most promising, and it is this idea which has inspired this book. In Part I is told the story of the forest—how it grows, how it is managed, the life of a forester, etc., and an effort has been made to bring out the romance and charm attached to the forest and at the same time give a true picture of methods and conditions which are found in the United States. The more tech-

nical matter concerning identification of trees and woods has been put in Part II, and here will be found material of interest to the nature student or the Boy Scout desirous of earning a merit badge in Forestry or Conservation. Technical descriptions regarding methods of forest management, etc., have been intentionally omitted.

In the Appendix will be found a list of general reference books on Forestry, and in addition the titles of some good boys' books dealing with the life of a forester or the lumberman and describing the drive, etc. This will make further reading along forestry lines possible.

If this book will awaken the love of the forest in the heart of Young America, and a realization that forestry is necessary for the comfort, health, and prosperity of future generations, the object of the author will have been attained.

To those who have assisted with criticisms and suggestions, the author expresses his grateful acknowledgment.

FREDERICK FRANKLIN MOON.

SYRACUSE, N. Y.

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CHAPTER I

WHAT IS FORESTRY?

WHAT scenes come to your mind when the word forestry is mentioned? Do the figures of Robin Hood and his merrie band clad in Lincoln green pass before your eyes; do the rifle shots of pioneers like Boone and Crockett ring in your ears, or do the stirring scenes of a logging camp with its busy axmen and straining horses and its manifold activities pass before your eyes? Whichever scene this magic word conjures up, it is safe to say it is tinged with romance and rich in adventure.

Now let us see what forestry really is.

Forestry Defined.—Forestry is the raising of repeated crops of timber upon soils unsuited to agriculture and has been extended to include the proper using of these forest crops. Forestry is not agriculture because agriculture has to do with tillable fields and level land, whereas the forester concerns himself with land too steep or too stony to till or too barren to raise farm crops. Thus forestry and agriculture are separate and distinct. Both are concerned with land and a proper practice of both agriculture and forestry is necessary that every acre of land in this country shall be put to its best permanent use.

Forestry and lumbering are not the same either, although conservative lumbering, the reaping of the forest crop, is a part of forestry. The average lumberman of today is not interested in the land after the present crop of timber is removed. He either cannot or will not hold the land for repeated crops of timber, and on this point the difference between lumbering and forestry hinges.

City forestry, of which much is heard at present, is not really forestry at all. It is caring for shade trees in the streets and parks rather than raising trees for lumber purposes. However, it is an extremely important phase of tree culture as shade trees and parks add much to the health and comfort of the city dweller. Besides, a man who is interested in the shade trees in front of his city residence becomes an easy convert to the cause of forest conservation, which means the proper use of our forest resources.

So we see that forestry actually means using the forest, cutting out the mature and overripe trees and giving the little seedlings beneath more light in order that they may grow up and furnish the succeeding crop of timber.

With the vast stretches of woodland that can be seen from the hilltops in nearly any country region of the United States the question arises: is there any need of raising timber crops? Will not Mother Nature always provide timber enough to furnish us with houses and furniture? Indeed forest conservation is needed for a variety of reasons which will be very briefly discussed, the most important being that in the United States there are vast areas upon which only trees will grow, and to allow them to lie idle would be very poor management on the part of our Government.

If land is too steep or rocky to cultivate or the rain-

fall is too slight to raise field crops successfully, the forester claims that such areas should not be allowed to lie idle, but should be made to yield repeated crops of timber, and aside from supplying the locality with this useful material, the owners will receive an income from their property, otherwise unproductive.

The civilization of North America is practically founded on wood and at present we are using our timber three times as fast as it grows. Over half our population live in wooden houses and two-thirds of our citizens use wood for fuel. Every boy realizes that our household furniture is almost entirely made of wood; that our newspapers and magazines are composed largely of wood pulp, and that the railroads upon which our foodstuffs and clothing are transported have not yet found a satisfactory substitute for the wooden railroad tie. Indeed wood is indispensable; but unfortunately through reckless cuttings and forest fires over half the original forest has been destroyed. When the present virgin forests have disappeared we shall be compelled to use small knotty second growth timber of vastly inferior quality and a timber famine manifesting itself in high prices and inferior forest products will be felt.

Even could substitutes be found for wood products a certain amount of the country would have to remain under forest cover, for it is generally believed that if less than twenty per cent of the land area of a continent is covered with forest growth in time the country becomes arid. The effects of forest cover in improving the climate by checking the force of harmful winds and in controlling the run-off of spring rains have been mentioned and a theory has been recently advanced that rains in the interior of a continent are largely dependent upon the presence of forests lying across the track of the

prevailing winds. In some parts of the United States the indirect influences may be more important to the community than the supply of timber which the forest provides.

Original Forests.—When the first settlers landed upon the Atlantic Coast there stretched before them from the ocean to the treeless prairie, over twelve hundred miles, a vast forest, unbroken, except for occasional Indian clearings, the like of which the world has never seen.

Beyond the prairies the Rocky Mountains and Pacific Coast forests were to be found in all their magnificence, favored by a temperate climate and sufficient rainfall. For density and quantity no region on the globe could exceed this store of timber.

The original forest area covered about 850,000,000 acres and contained 5,200,000,000,000 board feet of timber. As a result of clearing land for agriculture, lumbering and forest fires this forest has been reduced to 545,000,000 acres which contain about 2,500,000,000 board feet. In other words since the settlement of our country over half the original timber supply has been cut and burned, and today our nation is using twice as much timber per capita as it did fifty years ago.

Early Need of Forestry.—In spite of the vast storehouse of timber lying close to the colonial settlements, lack of roads often made fuel and construction timber rather difficult to procure and the pinch of timber poverty was often felt.

William Penn in 1682 stipulated that one acre should be kept in the forest for every five acres cleared by those who purchased lands from him. In 1795 the Society of Agriculture of New York published a report on the best mode of preserving and increasing the growth of timber and a few years later the Federal Government appro-

priated money for the purchase and preservation of timber for the use of the Navy. Under this and subsequent acts land suitable for the growing of live oak was purchased, acorns were sown and forest conservation for naval purposes only had a short inning.

Following the Civil War the exploitation of the West opened up virgin fields and lumber consumption increased tremendously with only an occasional thought of the future of our forest resources. During the decade from 1865 to 1875 several important reports and opinions were rendered by prominent Americans. Professor F. W. Brewer in 1870 attempted to take stock of our forest resources and as a result of his efforts and those of his predecessors the Committee on Forestry of the American Association for the Advancement of Science suggested to Congress the appointment of a commission of forestry to submit a report on the resources in and methods of preserving our forests. In 1876 Dr. Franklin B. Hough was appointed forest agent in the Federal Department of Agriculture.

Owing to the lack of interest and financial support little apparent progress could be made although a great deal of research was done and valuable information was spread abroad. In reality a splendid foundation was laid and much of the later work of the Forest Service proceeded along lines marked out by the early officials.

At that time most of the Western States contained large areas of land owned by the Government called the public domain. In 1891 Congress passed a law permitting the president to set aside from the public domain land to be used as forest reservations. President Harrison set aside the first reserves, and when his term of office was finished he had created public reservations to the extent of 13,000,000 acres. President Cleveland

also exercised the right of withdrawal by setting aside 22,000,000 acres of the best timber land that was owned by the nation. The best and most accessible timber land had already been sold for trifling sums taken up under the homestead and other land laws or given away so that lands then in the hands of the Government were largely confined to higher elevations and were more or less inaccessible.

This withdrawal aroused considerable feeling in the West. The Government for years had been lavish with land; millions of acres had been given to railway and wagon road companies. Large tracts of valuable farm land had been obtained fraudulently, being listed as swamps. Lumbermen had cut timber from land owned by the people the same as if they owned it and sheepherders and cattlemen had grazed their herds so long upon the open ranges of the public domain that they regarded this right to pasture as truly theirs.

To see this land withdrawn from public use aroused their ire and much of the opposition to the national forest policy which is still found in parts of the West is owing to the fact that the Government foresters insist that land owned by all the people shall be used for the benefit of all the people and not to the advantage alone of the local lumberman or ranchman.

Uncle Sam's Woodlot.—When Colonel Roosevelt became president the withdrawals increased enormously and at present Uncle Sam's woodlot contains 165,000,000 acres divided into 155 national forests worth over two billion dollars. Since forestry means use, this enormous area of forest land is being managed in such a way that the present generation can get the good of the Government-owned forests and yet they can be passed on to the next generation in good condition.

The ripe timber is sold as fast as there is a demand for it, but each tree to be removed is marked by the Government forester. The limbs and tops must be disposed of when possible, which decreases the fire risk as well as clears the ground. As a result the next crop of timber is already starting beneath the seed trees that are left. The lumber sales net almost one and one-half million dollars per year.

Fuel and fencing within reasonable limits are given free of charge to all local residents but they must pay a grazing fee if they wish to pasture their herds within the forests. It came very hard at first to pay for grass that had been free for years but the sheep- and cattlemen of the West now realize that Uncle Sam protects his pastures and as a result herds come out of the mountains in the fall in prime condition. The privilege is well worth the small price that is asked and at present the grass growing in the open parks beneath the trees on the national forests supplies feed for a portion of the year at least to not less than one-sixth the total meat supply of the United States.

The national forests are not locked against farming for, under the Act of June 11, 1906, farms to the extent of one hundred and sixty acres may be obtained as homesteads and in addition mineral claims can be secured by complying with reasonable restrictions laid down by the Forest Service. Finally, the forests owned by the people can be and are extensively used as hunting and camping grounds, for during the last year no less than 1,500,000 people used the national forests for recreation purposes, furnishing splendid hunting and fishing to those fortunate enough to live within reach. Thus in supplying timber for public sale, grass for local herds, homesteads for homeseekers and recreation areas for

town and city dwellers the forests owned by the nation as a whole are open to the freest possible use.

Future of Forestry.—This splendid national storehouse of timber, however, constitutes but one-fifth of the total stand of the United States, therefore will have relatively little influence in preventing any timber famines when the privately owned forests have been exhausted. More forest land should be acquired by the National Government and already under the Weeks law over 1,000,000 acres have been purchased upon the headwaters of navigable streams in the Appalachians and White Mountains. The States should be encouraged to extend their holdings of timber reserves, which now comprise only about 3,500,000 acres. Private landowners, especially paper manufacturers and water companies—organizations with continuous existence—should be shown the value of forever keeping their wild forest lands producing crop after crop of timber.

One phase of timber production worth trying in this country is the raising of forests by cities and towns. Thirteen States have already made a small beginning, Massachusetts leading with a total of fifty-six communal forests. In Europe many such forests are operated by the villages, serving as a recreation ground and revenue producer at the same time.

The city of Zürich, Switzerland, possesses a forest of nearly 10,000 acres, which yields a net revenue of $7.50 per acre per year. Numerous other villages in Germany and Switzerland may be found where the revenue from the city forest pays a large share of the running expenses of the city.

Thus we see that in spite of the fact that forestry had its humble beginning forty years ago and did not begin to establish national forests on a large scale until

1901, enormous material strides have been made. An area five times the size of New York State is owned by all the people, intended primarily for raising timber but open freely to all kinds of proper use. Forestry means use and it is the aim of the Federal Forest Service to use the national resources in such a way that they may be enjoyed by the citizens of today and still be available for generations yet unborn.

This splendid movement, the conservation, the proper use, of our forests and national resources as a whole, is still subject to attacks of selfish or misguided men who urge that the resources withdrawn from the nationally owned domain should be put in the private owner's grip as soon as possible. The boys and girls of today, the men and women of tomorrow, should know that conservation means use and only by keeping the forests and waters under the control of the Federal Government can our resources be properly managed and conserved.

CHAPTER II

WHAT THE FORESTS DO FOR US

THE full value of forests to a community or nation is difficult to estimate because the forest touches the life of the people in so many different ways. Aside from supplying the saw timber of commerce, furniture, etc., it is used in structural ways for which no good substitute has yet been obtained. Even the substitutes, like steel and cement which are replacing timber in the building of bridges and houses, etc., require a considerable amount of lumber for their manufacture and transportation.

Minor products, like shoe pegs, spools and musical instruments consume an amount of timber that is astonishing. In New York State over 8,000,000 board feet of lumber are used each year in the manufacture of wooden novelties, and over 6,000,000 board feet are consumed in the manufacture of clocks and toys. Houses, furniture, railroads, shipyards, newspapers and books all depend upon the products of the forest. A shortage of timber would be almost as disastrous as a famine in foodstuffs.

Statistics are likely to be dry reading, and for that reason when the amount of lumber consumed in the various industries of this country is given, it will be expressed in terms common to our daily life. For instance, in the United States we manufacture each year no less than 40,000,000,000 board feet of sawn lumber. This stupendous amount is sufficient to make a boardwalk three feet wide six times around the world,

or would make a double row of frame dwellings, which being placed ten feet apart would extend from New York to San Francisco. As stated in the first chapter, fully two-thirds of our population use wood as fuel, and the 90,000,000 cords of fuel wood annually consumed would make a stack of wood four feet high and four feet wide running five times around the globe.

Americans are generally recognized as being the greatest newspaper and magazine readers in the world, and this statement can be well believed when we realize the amount of pulp wood which the voracious maw of our paper plants requires each year. The enormous total of 4,000,000 cords of wood is manufactured into paper pulp; which when turned into newspaper would cover a half a million acres with a single thickness. In fact, one daily paper in New York City consumes no less than twenty-five acres of spruce forest for every Sunday edition.

Indirect Influences.—In the first chapter brief mention was made of the indirect influence exerted by the forests; how the climatic extremes are moderated; how the force of hot dry winds in the prairie country is checked and that the spongelike action of the forest cover is of great value in controlling run-off and diminishing floods. In some parts of the country the influences of a cover of woody growth on run-off may be more important than its value as a source of timber. For instance, in parts of California where a continuous flow of water is necessary for irrigation, the presence of chaparral thickets upon the steep mountain slopes is sufficient to prevent the rapid run-off of the winter rains and to hold the water in the soil that it may be gradually released when needed. As a consequence, this scrubby growth, though not producing timber, is

of the utmost importance to the agriculturist and horticulturist of that region.

Concerning the influence of forests on climate, it may be said that large bodies of timber tend to make the climate more moderate. In the summer it is always cooler in the forest than outside in the open field, and strange to say it is warmer in the forest in the wintertime than in the open spaces.

Snow lingers longer in the springtime beneath the forest cover and in every way the forest tends to make climatic changes more gradual. For a long time scientists in this country were loath to accept the theory that forests had any influence on rainfall, although experiments by French foresters had indicated that extensive forest cover at high elevations undoubtedly increased the amount of rain and snow. However, recent investigations indicate quite clearly that rains in the interior of continental America are to a large degree dependent upon the presence of large bodies of timber situated in the track of prevailing winds.

Concerning the influences of forests upon run-off, the beneficial effects are much easier to prove. In fact, it is generally known that were it not for the presence of forest cover on the steep slopes of our watersheds, many of our streams would be raging torrents for a few days in the spring and dry, gravelly beds throughout the summer season. That a continuous supply of water for drinking or power purposes is lacking is often due to extensive clear cutting upon a large watershed.

The wonderful effects of forest cover in increasing the length of time in which a raindrop passes from the air to the creek or river below can best be likened to the action of a layer of sponges or blotting-paper

Courtesy Canadian Northern R. R.

THE FALLS IN FLOODTIME

Forests alone cannot prevent floods, but foreign experience has shown that reforestation of steep mountain slopes, together with a certain amount of dam and reservoir construction, enormously improves the behavior of streams subject to flood.

covering a tin roof. If water is allowed to fall upon a steep roof, it runs immediately to the spout, whereas if this same roof were covered with a layer of spongy material a very large amount of the shower would be absorbed and very gradually released.

In a light summer shower it is estimated that from twenty-five to sixty per cent of the rainfall never reaches the ground at all, but is caught upon twigs and limbs and trunks of the trees. After the shower has ceased this moisture is evaporated directly into the air without reaching the soil.

Of the rain that does reach the ground, a very large amount is absorbed by the humus, that organic layer of partly decomposed leaves and twigs which lies on top of the mineral soil. This humus has a marvelous capacity for holding water; in fact it can hold many times its own weight. The trunks of the trees and supporting roots form countless little basins on every hillside and when the humus has become thoroughly soaked so that it can no longer contain another drop, these little basins gently fill and overrun one into the other, allowing the water to reach the brook very gradually.

When the forest cover is removed the humus is decomposed by the air; the leaves, twigs and branches no longer catch the rain and as a consequence the water rushes immediately from the steep slope to the river bed below. In case of heavy rains the soil may be badly washed and gullied and large amounts of gravel and stones may be washed from the steep slopes upon the flats and fertile fields farther down the river. In many of the Southern States the heavy clay soils are often badly eroded during torrential rains, and it is no uncommon sight to see rolling fields located just at

the foot of the steep slopes badly cut by gullies two or three feet deep formed during a heavy thunder shower. Such lands, of course, should never have been cleared, because if the slopes are so steep and the soil so heavy that erosion is bound to occur, the best use to which such land could be put is the raising of repeated crops of timber.

The question of erosion in this country is one of great importance since no less than two hundred square miles of fertile farm lands are annually damaged by the action of erosion and flood.

In checking the force of drying winds, forest belts or windbreaks also play an important role. In certain parts of the Middle West, windbreaks are almost indispensable because the hot drying winds that sometimes sweep up from the South have been known to wilt a splendid field of grain overnight. Had windbreaks been planted every quarter of a mile across the track of the prevailing wind, the force of these winds would have been greatly checked; water vapor would have been added to the moving air currents, and the force and drying effect of these damaging gales would have been greatly reduced. Investigators claim that twenty per cent of the agricultural land of the level Middle West could be advantageously planted with windbreaks running east and west and on account of the protection afforded by these belts the remaining eighty per cent of farm land would produce as much as the total area at the present time. The beneficial effects of these windbreaks in diminishing evaporation from plants and soil are clearly felt one rod to their lee for every foot in height. That is, a windbreak ten feet high would exert a decided influence in checking evaporation one hundred and sixty feet to the leeward.

Regarding the general effects of forest, geographers maintain that at least twenty per cent of every country should be covered with forest growth, and that the desert conditions in Northern China and in parts of Southern Asia are largely due to wholesale forest destruction carried on for centuries. In fact, some of the fertile valleys mentioned in the Bible are now dry, barren and desolate as a result of the reckless destruction of forest growth.

Forests and Game.—The effect of forest cover on the presence of game and birds must be taken into account. For a long time the campaign to protect our furred and feathered friends was carried on solely by nature-lovers, tender-hearted people who loved the birds and animals and preferred to keep the forest populous with its glad-hearted inhabitants. Game conservation means more than a kind heart nowadays, for recent investigations indicate how close is the balance as maintained by Dame Nature. If man, in his eagerness to shoot, decreases numbers of birds, insect attacks will almost immediately increase in severity. In fact the spread of the cotton boll weevil in the Southern States is explained by some as resulting from killing off the prairie chicken.

By examining the crops of the birds common to orchard and forest it has been found that most of them are of enormous service to the farmers and fruit-growers by eating the scale or insects that prey upon the gardens and orchards. The forest and woodlot furnish ideal nesting and breeding-places and, as previously explained, the presence of forests on our watersheds is necessary in order to keep our trout brooks and fish ponds full the year round.

Some overzealous lovers of the woods think that they

Courtesy W. S. Carpenter

HUNTING ON SNOWSHOES

A nation fond of hunting and life in the open will remain strong, courageous and self-reliant. This effect of the forest upon the national character should not be overlooked.

must be left untouched to serve best as refuges for birds and game. Really the opposite is true for deer are larger and more plentiful where a part of the forest is removed, and every boy who has ever gone hunting with an air rifle knows that birds are most numerous in the edges or in more open parts of woods. The most blasting damage to the forest from the standpoint of fish and game is inflicted by a forest fire. True, the deer may find browse in a burn after a year or two but other game and especially fish are greatly disturbed.

For many years the continental forester has also been in charge of the game, and in German forests shooting privileges yield a round sum.

In this country the intimate relation between the forest community and its furred and feathered inhabitants is becoming appreciated and the forester of the next generation must be well versed in the art of game propagation.

Value of Forests as Conservers of Life.—There is a pretty legend current among the Arabs that to each man at birth is given a specified number of days to live, but that every day spent in the chase is not counted against his score. This is merely a fanciful way of conveying the idea that life in the open adds to the length of our days, as well as to their enjoyment.

John Muir, the eminent author-naturalist, used to preach upon the text that every man should take time to get rich, and when he was asked what it meant to be rich, he explained his own theory of acquiring wealth. His plan was to pack some meal, salt and bread in a haversack and strike out for the wilderness, and far up on the mountains close to the timber line, commune with Nature. Here in close contact with the elements he pondered upon the beauties of the forest, and moun-

tains and all the world has been richer as a consequence.

The value of the forests as health resorts is just commencing to be realized. The American people, sprung from a race of pioneers, naturally have loved the woods and all outdoor sports. Every red-blooded American boy living in the country or a small town passes through the hunting and trapping fever. In fact the lure of the forest follows him throughout life, with the result that as a nation we are the greatest exponents of life in the open. Camping, fishing, and hunting are enjoyed by millions of people and this value of the forest should not be overlooked. It rests the nerves of the tired professional or business man and restores health to the sick in mind and body.

In addition to maintaining health, the forest and forest air have a most invigorating effect upon invalids and especially upon people suffering with tuberculous troubles. Statistics prove that sixty per cent of the tuberculous patients going to the Adirondack Mountains are vastly improved.

Finally, the revenue brought into a forest region by sportsmen and campers amounts to a considerable sum. In Maine it is estimated that no less than $13,000,000 is spent each year by hunters, fishermen, and tourists who come from other States to enjoy the beautiful lakes and forests and the hunting and fishing they afford, while the annual bill of sportsmen in the Adirondacks approximates $18,000,000.

Viewed from every side, forests are of inestimable benefit and their recreation and health-restoring effect by no means constitute the least of their values. They are truly fountains of life and health.

CHAPTER III

SAVING UNCLE SAM'S BIGGEST BANK ACCOUNT

It is no exaggeration to say that the American nation is the most extravagant in the world. Endowed by Nature with wonderful resources, forests apparently boundless, rivers and lakes without number, possessing agricultural land of marvelous richness and extent and with mineral deposits of great variety, it is no wonder that as a people we believed our riches to be inexhaustible. This feeling, so often expressed, has given rise to a policy of wastefulness in managing our resources that is without parallel in the history of the world; and none too soon have we learned that all things have an end. The conservation movement of which so much has been heard during the past ten years is a nation-wide effort to secure efficient and economical use of our natural wealth so that we will not pass an impoverished country to our descendants. Conservation does not mean locking up the resources. Conservation means proper use.

One of the most frequent arguments which has been used against the conservation policy in general and the Forest Service plan in particular is that it meant locking up resources for the present in order that they may be used some time in the distant future. Nothing could be further from the truth. The present generation has rights which cannot be taken away and to deprive the citizens of today of the use of mineral deposits, forests, etc., would be a foolish thing to attempt. Conservation means using our substance with-

out waste for the benefit of the greatest number of people for the longest possible time.

Need of Conservation.—That conservation is sorely needed is clearly brought out by Gifford Pinchot in his splendid book "The Fight for Conservation." He arrays striking instances of prodigal waste and shows the crying need of prudence, thrift and foresight in the management of our national riches.

The question of the forests—how they have been handled in the past and how they must be handled in the future to supply a rapidly growing population with material absolutely necessary to our civilization—will be considered elsewhere. It is sufficient to say now that since the first Colonists felled the forest to make room for their fields of maize the total present stand of timber plus 200,000,000,000 board feet has been consumed, either as lumber or by the ravenous but avoidable forest fires. Regarding other resources the figures quoted to prove waste are equally startling. Of the total coal deposits as a rule only one-half is removed from the ground, leaving the remainder to be buried in the abandoned tunnels and workings, to be recovered at a prohibitive price if at all. Concerning the coal used, only five per cent of the total energy is utilized on the average and the most economical systems now in use obtain but twenty per cent of the total energy. There is certainly a possibility for vast improvement in the management of our fuel supply. Once it was thought to be inexhaustible, but already the coal fields in certain parts of Iowa and Missouri are exhausted. While it is believed that the supply of bituminous coal will last about two hundred years, the end of the anthracite deposits will be reached in from fifty to seventy-five years.

The waste of gas and oil has been equally reckless. Wells have been allowed to gush wild for months or to burn with little or no effort made to put them out. The amount of gas wasted in this way has been enormous. Countless instances could be given where vast quantities of oil have been wasted by soaking into the earth or running into streams following the "shooting" of a particularly good well. In some cases the oil was burned to get rid of an oversupply. Viewing the management of all the resources as a whole, there is great need for the application of foresight and economy to their management.

It is not too much to say that the broad conservation movement had its beginning in forestry. The campaign for better protection and closer utilization of the nation-owned forests prepared the way and public education carried on by the Forest Service had put the popular mind in a receptive state. The citizens of this country generally acclaim Gifford Pinchot as the father of the forestry movement but his services in extending a system of thrifty and efficient management to all the natural resources are not so well known. In President Roosevelt he found a zealous supporter and the conference of governors held at the White House in May, 1908, really marks the beginning of Conservation. The subsequent meeting held in December, 1908, followed by the publication of the official report, aroused public opinion most thoroughly and called the attention of the American people for the first time to the enormous waste in the past and suggested how in an orderly way this waste might be remedied. The National Conservation Congress has held several important meetings; no less than seventeen States have established conservation or kindred commissions and from obscurity

the term "Conservation" has become a household word in the short space of eight years. It is doubtful if any economic movement ever had a more rapid rise.

In order that a correct idea of the present situation may be obtained a brief review of all the natural resources will be of interest and at the same time the steps that are being taken to insure their proper use may be mentioned.

Land.—The most valuable of all natural resources to a nation is land for from it with the assistance of sufficient water and a favorable climate comes the food of the people. Unless a nation owns plenty of fertile land it is truly poor no matter how much gold or precious minerals it may possess.

Of the total area of the United States 1,900,000,000 acres (about 3,000,000 square miles) approximately forty-five per cent or 850,000,000 acres is in farms. Of the one-fourth held as forest mention is made elsewhere but in addition about one-eighth is cut-over timber land or covered with an open scrubby growth. One-fifth of the land surface is arid or at least requires partial irrigation while one twenty-fifth is swamp land which will require drainage before it can become productive.

Upon the 6,000,000 farms it is estimated that fully three-fourths of the owners are engaged in a kind of agriculture which may be well named "soil robbery." That is, by selling each year the fertility of the farm in the form of crops and by replacing little if any of the mineral salts removed, the power of farm land to produce rich crops is being greatly diminished. The farm yields are decreasing on half our farms and we grow but fourteen bushels of wheat per acre against twenty-eight in Germany, and thirty-two bushels per acre in England. Unless the farmers of this country commence,

by means of fertilization and the use of proper rotations, to build up the soil which they have long drawn upon, the future of this nation will be extremely dark.

Of the land now idle through lack of rain it is believed that fully 400,000,000 acres can be made productive by the use of irrigation, or dry farming methods but how much more practical it would be to make land now owned and tilled yield maximum crops by the application of commonsense principles. That the population of this country will double within the next seventy-five years seems more than possible and to feed so many hungry mouths will require the best use of every acre of land suited to tillage. It is only necessary to stop the constant drain upon the land and by practicing systems of agriculture which will at least maintain the soil fertility to keep this country the food warehouse of the world.

Not only is soil fertility lost through shiftless agriculture but great waste is caused by permitting erosion and beating rains to rob the land of its richness. Dr. Shaler estimated that no less than two hundred square miles of fertile farm land are laid waste each year as result of the action of water and when it is realized that the Mississippi River carries away 400,000,000 tons of sediment, representing the most fertile portion of the fields, some conception of the total loss may be gained. The remedy consists in maintaining a proper balance between agricultural and forest land. Land which is too steep should not be tilled but should be kept under forest cover as the tree roots bind the soil together and prevent it from being gullied by the rains and melting snows. In some places where bench lands are tilled it may be advisable to leave occasional strips of forest land between the tilled fields as the trees and

underbrush form small basins which check the force of the surface water. In China, land which is quite subject to erosion is terraced in order to keep the soil in place.

The farmer of the present faces a far different situation than the tiller of the soil a generation ago. Then if his fields showed signs of exhaustion there were virgin lands farther west to be had almost for the asking and he could acquire another farm and start anew. Today there is no possibility of wholesale exchange of old lands for new, for out of the 280,000,000 acres still owned by the Federal Government approximately 5,000,000 acres are capable of tillage when water is available. Moreover, at present there is very little land to be obtained from a generous government. The era of splendid giving is past.

No country has been more lavish with its land. Homes could be had almost for the asking and to encourage the opening up of the West with wagon and railroads enormous tracts have been given—altogether an area five times the size of Pennsylvania has been granted to the railroads—and a large proportion of these holdings are still owned by the large corporations instead of being split into small holdings as the Government intended. To schools in but thirteen of the Western States 67,000,000 acres were given, while the swamp land withdrawn from the public domain and granted to the States totaled 64,000,000 acres. Both are princely gifts. With the passing of the era of free land we have left behind the pioneer stage of national development. From now on it means careful use of our agricultural acres in order that we may feed the hordes that the coming centuries will see upon our land.

Waters.—In addition to the marvelous land resources which were originally owned by the nation, Mother

Nature has been no less generous regarding our water supply. For over the entire country the average rainfall amounts to thirty inches per year, an amount which if evenly distributed would be entirely sufficient for our needs. Combining the effects of our climate which is most favorable to the land and water our country is capable of producing practically any foodstuff common to the temperate zone. The total rainfall amounts to 215,000,000,000,000 cubic feet and is equal in bulk to ten Mississippi rivers.

The uses which water serves are countless. Plant and animal life could not do without it and these values of course are taken for granted. The part water plays in irrigation projects, in furnishing power, in filling streams and canals to provide cheap transportation are some of the other uses which water serves. Of the water which is now flowing idly to the sea, an authority states that were it put upon the arid land we possess it would yield foodstuffs to feed 50,000,000 people. The Reclamation Service has brought large tracts of land formerly arid to a productive state and although altogether only 14,000,000 acres out of the 40,000,000 acres in the country at large which can be irrigated are "under the ditch" the work is proceeding steadily. The land capable of irrigation when supplied with water will support 20,000,000 people on account of its great fertility. Our total water supply is ample. It is merely a question of getting it to the land which needs it.

While water is a splendid servant it is a bad master. The damage done each year by erosion (two hundred square miles of fertile land is laid desolate each year) and floods is enormous. The annual damage inflicted by floods is now in the neighborhood of one-quarter billion dollars, five times as much as it was ten years

ago. This damage can be largely attributed to reckless cuttings upon the principal watersheds, followed by forest fires. Unless strong measures are taken this country will find itself in the same situation as France, which has been compelled to spend millions of dollars to control streams which became unmanageable following reckless cuttings of forest land on mountain slopes made after the French Revolution.

The situation regarding water for power and for navigation purposes is practically the same, for to be useful a stream must have a comparatively even flow during the entire year. This condition may best be brought about by keeping the steep slopes upon the headwaters of the stream under forest cover and by providing reservoirs along the course of the stream to catch and hold the flood waters during the time of freshets, to be released during the period of low water. Both systems are necessary; each alone may prove insufficient, and extreme cases may be found where both may be used with little apparent effect, although it is believed from foreign experience that in most cases such a plan will help wonderfully.

Regarding water power, at present there are about 5,000,000 horsepower developed, while the amount capable of development is variously estimated at from 37,000,000 to 100,000,000 horsepower. With the discoveries permitting long-distance transmission of electric current the value of a small mountain stream becomes large. Not only will the water now running idly to the sea help in transporting our products over electrified railways but it will furnish the power to run factories and to heat homes, and finally, as in the Scandinavian countries, cheap power will restore fertility to the soil by taking nitrogen directly from the air.

The value of our waterways in affording cheap transportation to heavy freights has been overlooked for some time on account of the greater popularity of the railroads. Under present indications it appears that canals and inland waterways of all kinds are coming into their own. New York has spent over one hundred million dollars on her barge canal and the people recently voted in favor of an additional twenty-seven million dollars to complete the work. There are altogether in the United States 295 rivers considered navigable and the total length of their navigable waters amounts to 26,000 miles. Numerous State and local associations are interested in their development and the use of these inland waterways will doubtless be greatly increased when terminals, etc., are constructed. The maximum development of streams for navigation as well as for power purposes depends directly upon even flow of the run-off, which can best be maintained at the source by keeping the watersheds perpetually under cover.

Minerals.—At the risk of being tiresome it can be said regarding minerals as well as of lands and forests that the United States has greater mineral wealth than any country on the globe. While in the production of gold our output is exceeded by South Africa, we excel in variety, for there are only two or three metals of any importance which are not found within our boundaries. The most important metal which we lack is nickel. We produce two-thirds the world's output of petroleum; sixty per cent of its copper; forty per cent of its coal and iron; thirty per cent of its zinc.

The former waste of some of these minerals has been previously mentioned and their supply is by no means endless. The supplies of high grade iron ore now in sight will probably be exhausted by the year 1930, when

the low grade ores will be drawn upon. The deposits of anthracite coal will be completely consumed during the next fifty to seventy-five years while the bituminous may last two centuries and the supplies of natural gas and petroleum will doubtless be depleted long before the end of the present century. The total estimated supply of petroleum amounts to 23,000,000,000 barrels and the amount annually consumed is 265,000,000 barrels.

Animals.—The situation regarding conservation as applied to our animal life cannot be better expressed than in the words of Dr. Hornaday when he says: "Forty years ago the preservation of wild life was regarded chiefly as a sentimental cause of practical interest to the sportsmen only. Today it affects the lumber pile, the market basket and the dinner pail." While the North American continent with the variety of forage it afforded originally possessed game in marvelous variety and abundance great inroads have been made upon the nation's supply. Investigators claim that in view of the rapidity with which game can be killed with the modern repeating rifle or shotgun there is no species of game which can withstand the attacks of man. The Indian legend told that the buffaloes came forth in an endless procession from a huge cavern and that there would always be buffalo for the red men. Perhaps there would have been in spite of the fact that they killed them in hundreds by driving herds over high cliffs. With the coming of the white man the slaughter for the market commenced. Splendid specimens were killed for their skins or even for their tongues while the carcasses were allowed to rot. In place of the 5,000,000 which is the estimate placed upon the number in the United States

forty years ago there are now about 3000 buffalo; nearly one-half are in the large Government breeding parks and happily they are breeding quite rapidly.

In addition to buffalo, other splendid game animals have been wantonly killed. Antelope for years furnished the meat supply of the pioneers while on the prairie and the elk have been slaughtered in some cases for their heads or teeth alone. Eleven species of birds formerly common to the United States have been totally exterminated in their wild state and other species, like the heath hen, have escaped extinction by a very narow margin. Besides the terrific decrease in game animals owing to continued shooting by the market hunter, other conditions have worked against them. Their haunts have been invaded by the lumberman and the resulting fires have destroyed their cover. Sheep and cattle eat the ranges clean during the summer and late fall so that grazing animals like the elk find little to feed upon and die by hundreds of starvation. All told the amount of game today is only two per cent of what it was fifty years ago.

This wholesale destruction of game not only represents a loss which concerns us as lovers of the outdoors but by diminishing our animal life the balance of nature has been upset and the forests and fields pay the penalty. The public in the end pays the bill through the lumber yard and grocery store. Forty years ago orchards had little need of spraying. Now it is a continuous fight against the many pests which prey upon the fruit trees. Zoologists claim this can be directly traced to the great reduction in the number of birds which formerly kept these enemies in check. The rapid spread of the boll weevil, the arch enemy of the cotton planter, is attributed to the killing off of the

Courtesy Canadian Northern R. R.

OFF FOR THE HUNT

While the Indians killed large quantities of game, its rapid disappearance in this country dates from the arrival of the white man. No species can withstand the modern repeating rifle or shotgun.

prairie chickens in Texas. Most of the birds and animals of the field and forest have a part to fill in the Creator's great plan and the destruction of a species means far more than wiping out of a family of God's creatures which can never be created again. It means the destruction of a small cog in the great machine. Some animals, however, like the gray wolf and one or two of the hawks, are truly undesirable and their killing is justifiable.

The resources just listed form the evident resources; those that quickly come to mind when the riches of a nation are thought of. It remained for the Third Conservation Congress in 1911 to add to this list—the conservation of human life and energy. This resource of a nation is so necessary that everyone takes it for granted, yet how much has it been overlooked! The waste of life in our mining operations and upon our railroads has been the marvel of Europe while through lack of organized effort but a small fraction of our total energy has been utilized. The American nation has succeeded because of the wonderful natural richness of this continent and because the climate and the mingling of bloods of all races has given the American people a boundless supply of energy of mind and body. This energy, together with the courage inherited from the pioneer, and unlimited opportunity has builded a nation in one hundred and forty years without parallel in the history of the world.

The Future of Conservation.—The above list briefly states what riches this country was given in the beginning and what we and our forefathers have done with the talents. Our stewardship has been remarkable chiefly for its lack of thrift since we have drawn heavily upon our store and have almost used up some of the

cherished possessions. Fortunately a start has been made toward the protection of the natural resources and future generations should receive a fair share of their inheritance if the plans now being laid by the far-sighted leaders of the conservation movement do not sadly miscarry. A brief review of these plans will be highly interesting.

Concerning the method of handling the land now owned by the Government, while the period of free land has passed and there are but few homes to give away, land is still extremely cheap in comparison with that in the Old World. The Federal Department of Agriculture is co-operating with the States and the various experiment stations give advice freely regarding the raising of crops, the proper fertilization and rotation to practice. With the spread of the co-operative system of marketing farm products, agriculture in the United States will be upon a sound basis, as the farmers will receive a larger portion of the market price of his crops and will be correspondingly prosperous. Upon economical agriculture largely rests the future of the United States.

The waters of the country are being more freely used and better controlled each year. The Reclamation Service is making the desert bloom like the rose in bringing water to lands already possessing plenty of salts and sunshine and new homes are being supplied to the small farmer upon easy terms, which will permit him to pay for his ten to forty acre tract in from ten to twenty years. The inland waterways are receiving the attention of Congress and the various States, so that rivers capable of navigation will be used to transport bulky freights at a fraction of railroad rates. The development of water power is proceeding apace.

Much of the privately owned power is being held against the day when it will be more valuable, but the Government, while anxious to have the power sites it still owns quickly developed, is absolutely opposed to their sale. The method appoved by the Forest Service advocates the lease of such sites for a long term with the privilege of regulating the rates charged to the local consumer of power. When once the power people realize that Uncle Sam intends to hold on to his supply of "white coal," as water power is frequently called, development will go on apace.

The question of flood prevention and erosion is largely a matter of State and individual concern, although the proper kind of agriculture on steep slopes —alternating belts of forest, contour plowing and terracing—will help as far as erosion is concerned. The prevention of floods is largely a problem of the various States, although in some cases where a particularly unmanageable river rises in one State and inflicts heavy damage on an adjoining State, Government aid may be necessary. With the Forest Service acquiring lands on the headwaters of the larger streams and with the numerous State and local organizations being formed interested in the waterways and rivers of the country, progress along these lines must surely be made.

The mineral lands which have passed into private hands are of course the property of the present owners to be handled as they see fit. They were acquired for the most part for very little money and as a consequence a certain amount of waste was not surprising. With the rapid decrease in the nation's supply of iron, oil, natural gas, etc., the price will rapidly rise, and the increase in value will doubtless lead to more

economical use. Concerning the mineral lands held by the Government a mining claim may be located upon the public domain or within a national forest and if there is ore there in paying quantities the mine may be obtained practically without money and without price. Coal and oil lands, etc., are no longer given away to corporations or to individuals. They are leased generally upon a royalty basis.

In spite of the fact that ninety-eight per cent of the animal life found upon this continent fifty years ago has disappeared the situation is by no means as dark as it was eight or ten years ago. Chiefly as a result of the splendid work done by such men as Hornaday, Walcott, Shiras, Bayne, and others, the public has been awakened to the economic as well as sentimental loss which would be suffered were our birds and game to be slaughtered without restraint. Fish and game leagues have been founded all over the country; many of the States have passed more stringent laws and are better enforcing the laws now upon the statute books, and Congress in addition to acting favorably regarding the protection of migratory birds has established several game refuges. The next step aimed at by the champions of our wild life is to have a portion of every national forest made a game preserve where the birds and animals common to that region may breed and multiply. It is sincerely hoped that such refuges may be established. So long as the young men of a nation hunt and fish they are virile and strong and a plentiful supply of game is desirable that the coming generations may be red-blooded men fond of outdoor sports.

Scientific management as applied to labor is endeavoring to make every foot pound of muscle labor and every bit of nervous energy yield the largest re-

turns. By the proper application of their strength men are able to lay several times as many bricks in a day or to transport several times as much iron without fatigue. It is simply a question of doing it the easiest way and cutting out waste motions. To be a truly efficient nation this system should be greatly extended.

The effort to conserve human life, health and energy linked with the conservation movement as a whole is occupying much attention at present. In our mad rush to get things accomplished there has been an appalling waste of life and health in the past. Men like Holmes, Wiley and Lindsay have been preaching that human life and health, manhood and womanhood, boyhood and girlhood are the most precious resources that this nation possesses. It is gratifying to note that their warnings have been heard and that their advice has been heeded to a large degree.

With the passing of the period of free land we entered the middle age of our national life. It is high time that we discard the reckless and extravagant ways of youth and commence to use our wealth soberly and thriftily. President Roosevelt stated at the White House conference that the conservation of our natural resources was the most important question before this nation and this remark is as true today as it was eight years ago. Every citizen who is truly a patriot should do his share toward making the America of tomorrow a more comfortable, more prosperous and a better place in which to live for the benefit of generations yet unborn.

CHAPTER IV

HOW BIG TREES FROM TINY SEEDLINGS GROW

JUST as a boy needs plenty of nourishing food, water, pure air and rest for his development, forests like other plant communities need certain factors for their proper development. Air, light, and heat, and moisture and plant food drawn from the soil are necessary for tree growth.

Air is a requisite since it contains the oxygen which nearly all living organisms must have. Trees, like all plants, breathe in oxygen and in addition to consuming oxygen they also withdraw large amounts of carbon dioxide from the air which is afterward combined in the presence of the chlorophyll of the leaves with water to make starch and sugar.

Light, of course, is indispensable to growing trees. It supplies the necessary energy for the assimilation of food, and if light be removed the leaves soon lose their green color and become incapable of manufacturing the plant food, sugars and starches from carbon dioxide and water. Different kinds of trees vary in their light requirements. Some trees such as red cedar, gray birch and most of the yellow pines of the South and West need full sunlight for thrifty growth and are called "intolerant" because they cannot endure shade. Others, like hard maple, spruce, and hemlock, can endure plenty of shade and are said to be "tolerant." A tree can ordinarily live with less than the full amount of light demanded by that species but to thrive and

produce fertile seed plenty of light, as well as food and moisture, is absolutely necessary.

The influence of heat upon tree growth is very much the same as light, for each species to assimilate its food properly, to grow and to reproduce must have a certain amount of heat. Tropical plants, of course, find the climate of the north temperate zone inhospitably cold, and trees from the north cannot long endure in the moist tropics on account of the continuous warmth. Plant life practically ceases growth at freezing temperature although in the polar region certain arctic plants are found growing through the snow in the springtime.

Moisture, aside from its influence in controlling temperature of the trees and the forest by evaporation and transpiration, is necessary to dissolve the salts in the ground so that they can be drawn in through the cell walls of the root hairs. It is also necessary for assimilation and growth, for in addition to being a component of plant food, a large amount of moisture is needed by the dividing cells in the growing parts of the tree. The amount of moisture consumed by a mature forest is extremely large. A mature beech forest consumes no less than 350,000 gallons of water per acre during the growing season.

Satisfactory soil conditions are indispensable to forest growth and in spite of the fact that a relatively large part of the tree is made from water and air, unless the soil be deep and permeable the tree cannot thrive although it may drag out a poor existence for years. On thin, stony or barren soils the form of a tree is generally crooked and stunted, just as a child who has been compelled to live on scanty fare never becomes a straight robust man.

Evergreen trees are far less exacting regarding soil and moisture requirements than most deciduous varieties. As a rule conifers demand only one-sixth to one-tenth as much moisture and one-quarter to one-half as much fertility, so that pines, spruces, firs, etc., will grow well on soils that would afford poor accommodations to oaks, maples, beech, etc.

How a Tree Develops.—So much for the general factors required for plants. Now in order that we may clearly understand how a forest develops and its relation to its surroundings, the growth of the individual tree must be studied.

A tree is composed of roots, stem, branches, and leaves, and for reproducing the species, to the above flower, fruit and seed must be added.

Roots really serve two purposes, they anchor the tree firmly in position, defying the effects of wind and snow, while at the ends of the roots just back of the tip or growing point are found delicate root hairs, which draw in the moisture and plant food dissolved in the water which surrounds the soil particles.

The stem and branches are the framework of the plant which support the leaves; the latter serve as the stomach and lungs at the same time. The soluble salts coming in through the delicate cell walls of the root hairs pass up through the sapwood to the leaves. There the water is combined with oxygen, and carbon dioxide found in the air is taken in through openings—"stomata"—found on the under side of the leaves. These two ingredients are combined in the presence of a green substance called chlorophyll, found in the leaf cells, to make starch and sugar.

Any water that is not used by the leaves to manufacture plant food passes out through the stomata as

watery vapor leaving behind the mineral salts which were dissolved in it. Thus the leaves and twigs are always very rich in these salts accounting for the fact that forest mold composed of partially decayed leaves and twigs is very rich and fertile.

Indeed a forest adds continually to the fertility of the land upon which it grows. The trees and shrubs draw up water containing salts in solution from the subsoil many feet beneath the surface, and a large amount of these salts remaining in the twigs and leaves is deposited upon the surface when the leaves fall. In addition the nitrogenous material in the leaf litter makes the surface very rich so that on sandy soils splendid crops can be raised for a few years after the forest has been removed. When the humus is consumed, however, the land becomes too sterile for profitable agriculture, and after being tilled for a few years may be abandoned. This condition of affairs is found in parts of the South and in the Lake States.

The course of the sap current in a tree is well known, but the reason for its rise is still unsolved. The raw sap comes in through the thin cell walls of the root hairs, passes through the supporting roots and up through the sapwood—the outermost layer of the trunk —to the leaves. After being combined with water and oxygen in the leaves, the energy being supplied by sunlight, the assimilated plant food passes down through the cambium layer—the growing ring—and the inner bark or bast. Various reasons have been put forward to explain the course of the sap in the tree, among which might be mentioned "osmotic force" (the attraction of a stronger solution for a weaker solution through a permeable membrane) and root pressure, or the suction set up by the evaporation which is contin-

ually going on in the leaves. None of these answers is clearly proven, so it can only be said of the power of sap transmission that it is a function of the living cell.

A plant or tree grows in height and diameter; and increase in these dimensions, of course, means increase in volume. Diameter growth is accomplished by the repeated division of the cambium layer (this layer has the property of adding a new ring each year) which lies between the sapwood and the inner bark, and as a consequence the tree has a ring for each year of its life. Height growth is dependent upon the vigor of the terminal bud which extends itself a certain amount each year depending upon the amount of energy stored up from the previous season. Thus growth is largely a matter of plant food and water with sufficient energy—light and heat—to work over the raw food into starches and sugars.

In a tree growth is from the outside and from the tip so that a nail driven into the trunk four feet from the ground will always remain the same distance from the ground, and the head will always be the same distance from the center of the tree. To picture how growth occurs, imagine a hollow cone (the annual ring) with a long tapering point (the latter being the height growth for the year) being placed on top of a series of such cones each year. Thus by sawing across a tree at any point we can count the rings and learn the age of the tree at that point.

If severe drought occurs in midsummer the tree may cease to grow but start up under the influence of later rains. Such conditions give rise to "false rings," but as a rule such rings are irregular and easily distinguished from the regular annual rings. Tropical trees do not grow by annual rings like the trees in the temperate

climates and the age must be guessed at according to the size of the tree.

During the early life of a tree height growth is quite rapid, the reason being that unless it is shade-enduring it must outgrow its competitors to obtain sufficient sunlight. During this period the struggle for existence is very keen in the young forest and many little trees are crowded out and die. After the period of rapid height growth has passed a tree begins to take on flesh—to increase in diameter and volume. In this respect trees are like some fast-growing boys, quite weedy and slim for a few years and then gradually becoming stout and strong.

How Trees Reproduce Themselves.—About the time the diameter growth is beginning to increase and a surplus of starch has been stored in the roots, etc., the tree is ready to produce seed, for seed production is largely a matter of sufficient food. When there has been a series of favorable years with plenty of rain and yet sufficient warmth and sunlight trees will produce large quantities of seed. These seasons of bountiful seed production are known as "seed years," although a little seed is produced nearly every year. These seed years come at unequal intervals depending upon the fortune of the tree three to five years previous. Seed years are not uniform within the species all over its range, as the white pine of the Lake States may bear a heavy crop of cones while the white pines of Maine will be absolutely barren. Trees growing in the open produce seed in larger quantities and at an earlier age than trees in the dense forest. As a rule trees in the open will commence to bear fertile seed at twenty-five years while those in the forest are incapable of producing a crop of seed until

about forty years old. Some trees may bear seed at from six to ten years of age but very often such seed fails to germinate.

Mother Nature seems extremely anxious to have tree species distributed as widely as soil and climate will permit and so we find various devices to secure the scattering of seeds.

Willow and poplar seeds are attached to a fleck of down, and may be carried long distances by the wind. Ash, maple and tulip trees have seeds with long wings which cause them to whirl in the air as they fall, greatly increasing the distance they may be carried by the wind. Some seeds like chokecherry or red cedar have a fleshy coat which is eaten by the birds who thus carry the stone or seed proper long distances. Still other trees, like chestnut, hickory and walnut, are largely distributed by squirrels since the nuts are too heavy to be carried by the wind and will roll or bound only short distances from the tree.

Most of the evergreens have winged seeds borne on the inside of the cone scales and in spite of their comparatively small wings they can be carried long distances in the autumn winds. An island lying one-half mile from the nearest shore of an Adirondack lake was completely burned over some years ago. All the trees were killed, the shrubs were consumed and the litter was burned down to the mineral soil thus destroying any seed which had previously fallen. Nevertheless within a few years a splendid stand of spruce seedlings was started from seed trees on the shore, the winged seed having been blown out to the island by the strong wind.

Seed in favorable years is produced in enormous quantities but a large portion of it never germinates.

Rodents consume enormous quantities of seed and in parts of the West seed collectors often get a large part of their supply from squirrel hoards. Often seeds may dry out before they germinate or if they do start to put out the little roots they may find that the soil conditions are uncongenial and hence die very quickly. Different species demand different conditions for a proper germination bed. Some trees like poplar and paper birch find congenial surroundings for seed germination in the ashes of a recent forest fire, because their seed germinates most readily upon mineral soil. When large tracts of spruce or pine country have been burned over these species often seed in upon the burn owing to the distance their light seed may be carried by the wind.

Other trees find moist soil and full sunlight absolutely necessary and hence willow seed dislodged by the wind may be carried downstream upon the water and find lodgment upon some warm sandbar, there germinate and grow most luxuriously. Still other trees find conditions favorable to germinate upon rotten logs, and it is no uncommon sight in the North Woods to see a row of yellow birches with an arch eight to ten inches high under the base of the trees, showing that seed had fallen upon a moist rotten log, had germinated, sent roots down to the ground and now that the old log has rotted away, the row of trees appears to be growing with part of their roots out of the ground. Whatever soil the seed falls upon the location must be the kind needed by the species or else the young seedling will last but a short time.

In addition to perpetuating their kind by means of seed certain trees have the faculty of sending up

Courtesy U. S. Forest Service

YOUNG FOREST STARTING BENEATH THE PARENT TREES

Most seedlings are rather tender at first and need protection from full sunlight. The slight shade cast by an open forest may be very beneficial.

sprouts from the root collar or starting suckers from the underground roots. The first method known as "coppicing" is quite common and such well known trees as chestnut, maple, ash, red oak and basswood sprout freely. Practically all broadleaf trees sprout during early life but some lose this faculty at a comparatively early age. As a rule the sprouting capacity is at its best before thirty years and most trees sprout indifferently after sixty years. Trees of seedling origin have more vigor and better sprouting capacity than those of coppice growth. A few conifers sprout but ordinarily the growth of such trees as shortleaf or pitch pine is comparatively short-lived. Redwood, however, commonly reproduces by sprouting which accounts for the large circles of trees found in redwood groves. They are the second generation growing around the parent stump.

The faculty of sending up shoots from the underground roots or "suckering" is a method of reproduction common to such trees as beech, black locust, poplar, etc. Very commonly a dense thicket of beech reproduction upon investigation proves to be a mass of suckers surrounding the stump of a tree cut a few years previously.

Development of the Forest.—In order that the life history of a forest community may be clearly understood let us watch how the forest develops. In many parts of New England, pastures or even farms were cleared from land which proved to be too steep and sterile for successful agriculture, so these fields were later abandoned. Within the last century many of these areas have grown up to splendid forests of second-growth pine or spruce, and the process was as follows:

From near-by trees with large spreading crowns a

plentiful supply of seed was scattered upon these open fields year after year. Of course countless thousands of the seeds never produced any seedlings. They may have been eaten by squirrels or field mice or they may have been parched by the sun or like the seed in the Biblical parable they may have fallen upon stony ground which the little roots could not penetrate.

After the course of four or five years numerous seedlings could be seen scattered about the open field, nestling in among the grass and weeds. They were rather far apart but these gaps were soon filled in during later bountiful seed years. At first each seedling had plenty of "elbow room," for growth above ground is not rapid during the first three or four years. The sensible little trees are developing a mass of fibrous roots underground, wisely preparing for future drought and lean years. After four or five years the seedlings seem to strike their gait, and commence to grow. The leader, as the terminal shoot is called, may be eight to ten inches high at the end of the growing season, while in favorable years white pines on good soil may grow thirty to thirty-five inches.

The side branches have also been growing and gradually the crowns of the little trees meet, the side branches interlace and the forest canopy is formed. From that time on the competition is extremely sharp and the race is assuredly very keen, for a tree that is once overtopped and deprived of sunlight is almost hopelessly outclassed. There is no handicap but each tree must run the race on its own merits.

When the lower branches become intwined they naturally receive little light. They shed their leaves which fall to form the carpet of needles upon the forest floor and later make the humus. The lower branches

soon die from lack of light and food and the next high wind or ice storm breaks them off leaving the lower part of the trunk bare of limbs. This process is called "natural pruning" and explains why trees which grew in dense stands in their youth produce such splendid clear timber free from knots. Whenever a tree is found with thick, wide-spreading branches low down on the trunk it is certain that this individual had full light upon all sides when it was a sapling else it would not have kept these limbs so long.

During this period of rapid height growth every tree is struggling for all the sunlight it can get. Each acre of ground has just so much rain and so many days of sunlight in the growing season. Naturally if the seedlings have been very densely sown by Mother Nature, say 10,000 or 15,000 per acre, there is not enough food to go around and those that were weak or a little slow in getting started fall behind. Once they are overtopped, sunlight is cut off which deprives the submerged tree of the energy required to assimilate its food and then it dies of starvation, or soon falls a prey to fungus or insect attacks.

In this way the number of pine or spruce trees standing upon an acre of the old pasture becomes greatly diminished during the first forty years of reoccupation. By that time the weakest have fallen down, have rotted and may have vanished completely beneath the needle carpet. The leaves and twigs which have fallen as well as the trunks, have decomposed to form the layer of dark mold or humus lying on top of the mineral soil while on top of the humus may be found the carpet of needles and twigs which have not yet been long enough exposed to fungi and bacteria to have lost their structure.

After forty years the mad race rather slows down. The period of most rapid height growth has passed and the three hundred or four hundred trees now forming the stand, tall and rather slim with crowns completely shading the ground are the picked survivors of the 10,000 that started and each is nearly as strong as his fellow. From now on they commence to take on girth like boys who suddenly change from gangling youths to sturdy young men. Good wide rings are laid around the trunks, covering up the places where branches formerly pushed through the bark. This means clear timber free from knots and easy to work, the kind that delights the carpenter or the pattern maker.

From now on our forest community loses a citizen from time to time, from lightning stroke, disease, insects, etc. The holes in the canopy are soon filled by the neighboring crowns which still possess the power of vigorous growth. The trees are now reaching maturity with tall cylindrical boles, having from fifty to sixty feet of clear length since the crown has been continually shortening. Finally a time comes when the crowns can no longer fill the gaps and the opening made by a fallen veteran remains open and permits the sunlight to reach the ground beneath the trees. The forest floor previously shaded and free from weeds now shows patches of grass here and there, the thick layer of humus begins to decompose under the influence of sunlight and the forest as a whole is ready to reproduce itself beneath its own shade. This period, known as "silvicultural maturity," occurs some time before the final breaking up of the old stand but nevertheless it marks the beginning of the end.

From now on the decline is quite rapid as measured in forest periods. The groups of seedlings found beneath

the openings in the canopy increase in height, they become larger in size and area as well, due to the falling of the encircling veterans. The seedlings become saplings; the giants fall, decay, become moss-covered, and finally go back to the soil from which they sprung, enriching it with the mold of their enormous trunks. The young saplings increase in length and girth, finally become veterans and in turn fall, to mold beneath the shade of their posterity. Long, long before, every trace of man's handiwork has disappeared and the forest apparently untouched has reclaimed the land which man wrested from its grasp for so short a time.

CHAPTER V

PROPERTIES OF WOOD AND THEIR USES

IN spite of being the oldest building material, perhaps with the exception of stone—for caves were probably used as dwellings in the earliest times—until very recent years little accurate knowledge has been at hand regarding wood.

Its very common use made investigations seem unnecessary and while steel and concrete are tested all through the course of their manufacture, only recently has the testing of timber been taken up as a business proposition. Trees do not grow like crystals according to mathematical laws. On the contrary, timber is anything but uniform in structure and strength, for two pieces taken from different parts of the same tree may act quite differently and trees of the same species which have grown in different parts of the country may differ greatly in their qualities. Within the same locality the kind of soils upon which trees grow affects the kind of wood they produce.

Each kind of wood has certain qualities which make it unlike other species; these characteristics are color, hardness, durability, grain, etc., and upon them depend the value of a given species in the arts. For construction work timber that is strong, durable, cheap and of large size is demanded. Cabinet and furniture makers require wood with a handsome grain that is hard, will not shrink and capable of taking a beautiful finish. Certain industries are based upon the chemical

composition of wood—for example the distillation of resin from the Georgia pine. Others must have woods with fiber of great length. The spruce of our Northern forests for instance is not only in great demand as a paper wood on account of the length of its fiber but also because its resonance makes it excellent material for violin backs and piano sounding boards. The violin makers of Europe will pay large sums for old spruce beams and joists in a house that is being torn down, as the well-seasoned wood is just what they need.

Gross Structure.—On cutting down a mature tree a marked difference is noted in the hue of the wood. In the center is a dark-colored core which is called the heartwood, while around the outside is a ring of lighter softer wood called the sapwood. The dark color of heartwood is due to the presence of certain materials like tannin, resin, etc., and its greater durability is also due to the presence of these substances. When wood changes from sap to heartwood additional amounts of wood substance called lignin are deposited upon the cell walls, making the heartwood stronger as well as darker and more durable. On account of its greater moisture content the sapwood is much more subject to decay and is less desirable as a rule. Hickory and maple are practically the only species in which the sapwood is preferred to wood from the heart. The heartwood is dead physically and its principal use is to support the tree. The sapwood, however, is very much alive because it contains the vessels which transmit the raw sap from the roots to the leaves. This relation between heartwood and sapwood can be clearly proven by examining many hollow old pasture trees. Old veterans may be found which are nothing but shells in which the heartwood has practically rotted out, leaving a hollow cylinder several

inches thick, yet from outward appearances the tree is as healthy as ever because the flow of sap from the roots to the leaves and down again to the different parts of the trunk is not interrupted. However, if a deep notch is cut completely around the outside—this is called girdling—and the vessels are cut, the flow of sap is interfered with, and the tree promptly dies.

The thickness and amount of sap and heartwood varies in different species and also in different parts of the same tree. Walnut and red cedar have comparatively thin sapwood; in the case of hickory, beech and maple it is quite thick, while in other trees, like hemlock, spruce and willow, there is practically no difference in appearance.

Upon close inspection the cross-section of the stump will show the annual rings which have been formed by the cambium layer. These rings are generally wide in the center of the trunk gradually narrowing as the outside is approached. This relation shows that the tree grew rapidly in youth and later on as the trees in the forest became crowded the diameter growth became smaller owing to reduced light and food. The true grain of wood, however, cannot be appreciated on a cross cut except in the case of certain trees like sycamore and the oaks, where it can be seen that the so-called "medullary rays" are very prominent. These rays are narrow bands of pith which transmit food and water from the living part of the tree to the heartwood. The full beauty of a finely figured species does not appear until the piece is cut along the radius, thus exposing these narrow bands of pith. Quarter sawed oak is a splendid example of such a figured wood cut on the quarter or along the radius.

In most trees there is a pronounced difference between

the wood laid on in the spring and that laid on in the summer, although trees like beech and maple show little difference. The spring wood which is laid on when the growing season begins and plenty of moisture is available consists of thinly walled elements which appear quite porous in such trees as chestnut and oak. This porous part of the annual ring gradually passes into the more solid summer wood where the structure is dense and thicker walled.

Color.—Presence of an attractive color in wood of a given species may greatly increase its value, although many of the so-called fancy woods are highly stained. The presence of color in heartwood is due to resins, gums and oils which are usually considered by-products. While certain species like walnut or redwood have a uniform shade most others have lighter or darker streaks running through the colored portion. Most highly colored woods turn a still deeper shade on exposure to the air and, of course, the action of oils and finishing liquids in bringing out the color and grain is well known. While the color may appear quite intense, only a few woods contain dyes of marketable value and these are chiefly foreign; logwood and Brazil wood being the best known of the foreign species. During colonial times many colors were obtained from the forest for dyeing yarns and leathers, and the "butternut" jeans of the Confederate soldiers are well known. Osage orange, the roots of the barberry as well as the inner bark of black oak all furnish yellow dyes. The staghorn sumac, in addition to containing the necessary tannin for dressing leather, also supplies a dye which colors it yellow. The gathering of leaves and stems of this shrub constitutes quite an industry in certain parts of the South. Red gum supplies a purple dye

Courtesy Canadian Northern R. R.

STARTING THE BIRCH BARK CANOE

The forest supplied many necessities of life to the American Indians. From the bark of the white birch they made their graceful canoes.

which was used by the early Swedish settlers in New Jersey and Pennsylvania, while from the roots of flowering dogwood the Indian warriors obtained the brilliant color known as "Indian red" which they used to stain their buckskins and feathers for their head dresses. With the present scarcity of foreign dyes it is extremely probable that vegetable dyes will play a still more important part than at the present time, and the forest trees may be called upon again to yield their coloring matter, especially since they are more durable than coal-tar dyes.

Grain.—One of the first questions that is likely to be asked regarding the quality of a wood is, whether or not it is straight-grained, for upon the direction of the growth rings depends the ease with which a board may be broken. Sawed boards are often easily cracked because the course of the saw did not follow exactly the direction of the fiber. When wood is split, however, the ax or knife follows between the fibers which accounts for the fact that split wood is much stronger than sawed. Certain species are notoriously cross-grained and boards from such trees as elm and red gum not only season with difficulty, but the extreme irregularity of their growth rings makes them hard to work after sawing. The figured grain in certain species like oak and beech is due to the presence of narrow bands of pith called medullary rays, but in addition to patterns of this sort certain species, like the sugar maple, are very likely to have variations in growth which make them extremely attractive. The so-called "bird's-eye maple," resulting from a lifting of the growth ring by a tiny knot, is highly prized and such a tree is worth considerably more than the normal straight-grained maple. A fine-grained wood, of course,

finishes more readily and on account of the narrowness of the growth rings presents a more uniform appearance after it has been planed and polished.

Durability.—The length of time a given species will resist decay in use depends upon the species, the rate of growth of the individual and to a certain degree upon the soil which produced the tree. Broadleaf species are usually more durable than evergreens, although the wood of the hard pines will outlast that produced by the willow or cottonwood. In fact the cypress, one of our most durable woods, belongs to the evergreen group. So lasting is this wood that it has been called "the wood eternal," and after seeing the splendid condition of the shingles upon some of the old Southern plantation houses, the description does not seem inept. Certain woods, like chestnut and the oaks, contain substances called tannins which are antiseptic and retard bacterial action; the oil in cedar has the same effect.

Dense hardwoods are usually quite durable, although such heavy woods as maple, birch and beech are by no means lasting. In these cases the large amount of moisture and starch contained in the wood makes them especially subject to the action of the agencies of decay. Mesquite, a heavy dark wood of the Southwest, is especially durable. This tree grows in such arid surroundings that it develops a deep wide-spreading root system. It is this tree which gives rise to the remark that in certain parts of New Mexico it is necessary to dig for firewood as more of the tree is found below than above the surface of the ground. It is an actual fact that a tie made from this species has remained in position for thirty-two years and was then absolutely free from signs of decay.

Regarding the rate of growth certain of the hardwoods, like chestnuts for instance, are more lasting if they have grown rapidly; evergreens generally are more durable if they have grown slowly as there is a greater proportion of the heavy summer wood in the annual ring.

Thus hardwoods are likely to produce their best and most durable lumber when grown in the open on good soil, while the reverse is claimed to be true for the evergreens.

With the rapid increase in the use of preservatives a tree nowadays need only be hard. Resistance to decay can be acquired through chemical treatment. (See Chapter XII.)

Weight.—In spite of the fact that the wood substance produced by all tree species is the same weight—a little more than one and a half times that of water—the timber sawed from different trees varies considerably in weight. This is due to the compactness of arrangment of the wood fibers and the amount of air contained in the wood. Most of the pines will float when green, but after they have been in the water some time they become heavier than water and sink, owing to the fact that water has replaced the air. Both on account of the compactness of their structure and their moisture content few of the broadleafed trees will float, although some will do so after being dried out. The amount of heat that is obtained on burning wood depends largely on its weight and such heavy species as hickory, oak, and sugar maple yield the best fuel wood; in fact there is a direct ratio between the weight of wood and the heat it liberates upon burning. In a general way it may be said that the heavier woods are more valuable, as they are likely to be stronger

and more durable and possess greater fuel value. The lighter woods are inclined to season readily and to work easily, but usually lack strength and durability.

Strength.—A wood is said to be strong when it resists pressure or tension from various sources; the pressure may be applied either with or across the grain and different species show a varying power of resistance. Both longleaf pine and white oak resist pressure with the grain especially well and hence they can be used to advantage as columns where great weight must be supported. Other species show varying resistance to different kinds of strains and the Forest Service Timber Testing Laboratory at Madison, Wisconsin, has made many experiments on all kinds of woods to find out the uses to which they are best suited.

Within the same species, the strength of wood is due to condition, its freedom from knots and cracks and also to the amount of water it contains. Freshly cut timber is weak in comparison with the same stick when thoroughly seasoned. The weight of wood is generally a good measure of its strength, as woods that are heavy when dry contain a large amount of wood fiber and consequently break or crush with difficulty.

Other properties such as toughness, cleavability, elasticity, etc., might be mentioned. Hickory is especially valuable for use in wagon making on account of its hardness and toughness and from the elastic white ash are made much of athletic equipment so dear to the heart of the outdoor boy or man. Baseball bats and snowshoes are made from ash, as it combines toughness and elasticity to a marked degree.

Defects.—Wood, however, is rarely perfect and may contain defects which will seriously impair its strength or prevent its use for a given purpose. Knots are per-

haps the most common defects in wood. They represent the portion of a branch which is imbedded in the tree and are especially common toward the heart. When trees have grown in a dense stand the lower branches soon die, are broken off by wind or ice and the later growth rings cover the knots up. That is why a forest of old veterans produces clear lumber on the outside while the core of the trunk contains many knots. Another common defect in lumber is what is known as a "shake," which is the separation of the fibers in the trunk. This may occur as a split running from the center out along the radius. If several clefts are present, the condition is known as "star shake." Another type of this defect is the "cup" or "ring shake." This is caused by the separation of one or more growth rings from the adjacent rings. When a log with cup or ring shake is sawed up the shaky portion separates from the remainder and a bad case may completely spoil the log for lumber. Such defects are common in nearly all overmature trees, and while usually they occur only in the butt log, they may affect the whole trunk and some of the larger branches.

Possibility of Substitution.—No other nation uses wood as freely as ours and the remark that the civilization of North America is founded upon wood is as true today as formerly. Today we are using two hundred and sixty cubic feet of wood per year for each citizen of our country, an amount twice as much as was used fifty years ago and six times as much as is used per capita in the German Empire. With the rapid growth in the steel and concrete business which has taken place during the past decade the prediction has been freely made that these materials would rapidly replace wood. While it is true that bridges, houses,

telegraph poles and floors are now made from reinforced concrete, and that passenger coaches, desks and office furnishings are made from steel, nevertheless it is undeniably true that wood has qualities which for certain uses make substitutes impossible. Both steel and concrete railway ties have been tried and are used in some places with good results, but on account of their stiffness and the tendency of the steel fastenings to break suddenly under normal loads, the roadbed is rather less comfortable and safe. Where a fast schedule must be maintained and the comfort of passengers and the durability of cars and engines are chiefly desired nothing will take the place of a good tie made of wood.

Only about one-fourth of the total amount of wood used is for construction purposes and regarding the remainder it is doubtful if substitutes can be conveniently found. Paper-making draws heavily upon the forest each year and the chemist has yet to find any substance both cheap and readily accessible which will take the place of wood. In spite of the use of asphalt and stone for paving, wooden blocks are still used for surfacing the streets in our large cities.

In short the general tendency is toward a larger consumption of wood each year, and while there is less talk today of a timber famine than was heard a few years ago, it is safe to say that timber is destined to sell at much higher prices during the coming years, for it is true that in most instances timber has been sold for less than its growing cost.

With the vast acreage in the United States which can be used for no other purpose, we will always have forests and in fact we will need them as much for their influence on climate, the run-off of our streams, etc., as for any other purpose.

While the increase in lumber values which is bound to occur may cause the use of substitutes to some degree it is safe to say that wood in the future as in the past will be indispensable to our civilization, for it is hard to conceive of any substance, natural or artificial, which is so easily produced, so readily worked into shape and so generally useful as wood.

CHAPTER VI

MAKING MONEY OUT OF FORESTRY

Most owners of forest land demand that their property shall yield a high revenue and consequently they desire their trees to grow as fast as possible. This recalls the story of a hustling Yankee who was traveling in the piney woods of the South. One day he came across his first razor-back hog and was astonished at its thinness and the speed with which it could run. On asking a local resident why he didn't pen his hogs up and shorten the fattening time, the native replied, "Whut's time to a hawg?" It makes no difference to a tree how long it takes to grow to saw log size, but it makes a great deal of difference to the owner.

The timber put on our markets today for the most part took Mother Nature from two hundred and fifty to three hundred years to produce, and it is extremely unlikely that future generations will ever see trees of that size outside of occasional parks. The forester aims to produce trees in as short time as possible and by thinning the forest in youth and thus diminishing competition for light, food and moisture he forces the growth into selected trees. Naturally, this provides better timber in far shorter time, to the increased profits of the owner.

Increasing the Growth.—By making thinnings at the proper time sprout chestnut will yield railroad ties in thirty-five years, whereas if left untouched

forty-five years would be none too long to produce timber of this size. Such cultural methods are worth while and are being adopted by progressive land-owners in this country. Among the methods of managing the forest and increasing its growth "improvement cuttings" ranks as one of the most important. By improvement cuttings, we mean removal of timber from immature stands for the purpose of hastening growth, reducing competition, and improving the mixture of trees in the forest. In some cases cuttings may be made in stands of small sprouts where the material is too small to pay for the cost of removal, but such cuttings, or cleanings, as they are called, are hardly practicable in the United States, on account of the high labor cost and the comparatively low value received for timber. In fact cleanings may cost from one dollar and fifty cents to three dollars per acre.

Under the average conditions in this country it is advisable to allow a young forest to grow untouched until the trees are large enough to pay for the cost of removal. Then a thinning can be made which will remove competing trees, defective and diseased specimens and "weed trees," as the species of no commercial value are called. The trees of desirable species remaining upon the ground receive more light, more food and moisture and consequently commence to grow much faster. For instance, in our Eastern forests such trees as ash, basswood, tulip, poplar, red oak, etc., are generally favored over the slower-growing and less desirable beech, maple, black oak, horn beam (forest weeds), etc. Rapid-growing conifers like pine and spruce are to be preferred to the slower-growing and less valuable species, like hemlock and white cedar, although in each case the kind of soil must control the species to be favored.

As a rule conifers should be encouraged upon poorer situations since they make less demand upon the soil for plant food and moisture. Practically any boy in the country can plan the cuttings in the farm woodlot greatly to improve its conditions. Of course the easiest scheme would be to cut the winter's supply of wood right near the road where the trees could be easily cut up and loaded on the sled or stone boat. This recalls a story told about Daniel Boone, who it is said always moved his abode to a new spot in the virgin wilderness when the clearing about his cabin became so large that trees for fuel would not fall across his door.

Starting the Forest Naturally.—In this cutting for the winter's wood, the slower-growing and imperfect trees can be removed, favoring the fast-growing valuable species. Too many trees should not be removed from the same group, as big holes in the forest cover will expose the soil too much and reduce its fertility. In such a removal the starting of new growth is not intended, although a heavy improvement cutting in a forest old enough to produce seed may result in a fine stand of young seedlings the following season. This, however, is by accident rather than design. Where it is intended to start a new forest and the proper seed trees are found in a mixed forest, the first step should be to remove the forest of weeds, like hornbeam, blue beach, etc., and trees of slight value whose seed is not wanted. Ordinarily the removal of such trees and those which are diseased and defective will open the canopy sufficiently to give full light to all parts of the crown. This results in marked increase in seed production. The seed falls, germinates, and the young seedlings commence to grow. Under ordinary circumstances, there would not be sufficient light

for them to thrive, so that a second thinning is necessary four to five years later. Subsequent thinnings are made from time to time, depending upon the needs of the seedlings beneath, until the last of the old parent trees are removed and the young stand of timber beneath is exposed to the full sunlight. This method of reproducing a stand by cuttings is known as the "stand method," or the "method of successive thinnings," and is especially to be commended in regions where the forests cannot be clear cut or with heavy-seeded species.

Where light-seeded species form the forest, strips two hundred to three hundred feet wide may be cut across the direction of the prevailing wind, and then the untouched strip of forest on the side will scatter seed upon the open area and gradually cover it with a dense crop of young seedlings. Or if the trees are especially wind firm, the entire forest may be clear cut, leaving five to ten trees per acre, and from these trees seed will be scattered that will start the second generation upon the cleared land.

Another type of starting forest growth called coppicing is practiced with species which have the property of sprouting from the root collar. Chestnut, maple, ash, oak, basswood, all yield readily to this type of treatment, and if cut young enough a dense thicket of sprouts will spring up which matures rapidly and produces a splendid crop of timber. This type of management, however, should not be used too many times in succession, as the vitality of the stand becomes lowered by repeated coppicings and the soil becomes exhausted from too frequent exposure to the intense rays of the sun.

The statement is often made that far better lumber can be produced by cutting off the lower branches of

trees and permitting the tree to lay on successive rings of clear lumber on top of the rather knotty core. Advocates of this plan claim that the lumber thus produced will bring a sufficiently large yield to pay the cost of this artificial pruning. On the other hand, men who have sawed second-growth white pine which was artificially pruned, claim that the lumber contains loose knots caused by the too rapid drying of the branch stub. Ordinarily if pruning is necessary to improve the appearance of woodland near the home, it may be done, but it should be considered a piece of landscape improvement rather than a forestry measure, as it is not believed to be financially profitable.

Artificial Forests.—One may ask what ends are served by starting a forest artificially when the forests grown by Nature have produced such magnificent timber. Briefly stated, forests are planted for three reasons.

First, it saves time in getting your forest successfully started. Nature is sure but slow, and may take forty years to get a forest started which contains the right trees. Planting, on the other hand, assures the right species at the correct distance for valuable growth. In some cases the wild seedlings sown by the wind are so far apart that bushy trees and knotty lumber are produced. In other cases, for instance with lodgepole pine in the Rockies, the young seedlings grow in such a dense thicket that proper development is impossible.

In addition, forest planting may be actually cheaper than Nature's method when you come to figure the cost. If it is necessary during a lumbering operation to reserve valuable timber trees for the purpose of seeding in the ground, from twenty-five to thirty dollars' worth of timber per acre may be left in these trees. There is a chance of this lumber never being harvested, as insect or

fungus attacks may lay them low before the young trees come to maturity and the land is ready for the next harvest. In many cases it would be far better business management to cut down these large overmature trees and spend a portion of the revenue obtained therefrom in planting the area with young seedlings or transplants.

Finally, forest planting represents a good financial investment. In the past, owing to the enormous rise in timber values, many large fortunes have been made by purchasing wild forest lands. While forest planting offers no such speculative opportunities at present, nevertheless it does promise to yield at least four to five per cent compound interest on the investment.* Favorable laws regarding taxes on forest lands, and the vast improvement in forest fire organizations maintained by States, lumber companies and timber land associations are making this plan of investment much safer and quite comparable to long-term bonds. In spite of the fact that in certain parts of the country halfgrown timber may be bought at an extremely low figure, considering the vanishing timber supply, the idle land and water storage problems, reforestation on a large scale appears to be splendid investment for States, water companies, and any organization with continuous existence.

If it is wise to reforest non-agricultural lands, some may ask why not follow Nature's method and scatter seed broadcast upon the ground. The reasons against this method are as follows: In the first place the cost of seed in such quantities as Nature uses would be out of the question. For to collect cones, dry them, extract the seed, to say nothing of the labor of cleaning and scattering seed brings the per acre cost of such an

operation to a sizeable figure. At least five to ten pounds are necessary to sow each acre broadcast and with seed costing from seventy-five cents to one dollar and fifty cents a pound under the most favorable circumstances the expense is not trivial. Another reason why Nature's method is not always desirable is that it is decidedly uncertain. Birds, squirrels and field mice all eat most seeds with eagerness, and in many cases also, the tender rootlet finds it impossible to enter the soil if it is at all compact.

As the result of quite a few years' experience, it has been found cheaper and more successful in the long run to plant healthy little seedlings or transplants six feet apart. This requires 1210 trees to plant an acre of open field. The plants ordinarily cost from three dollars a thousand for seedlings to about six dollars per thousand for transplants, and the total cost for planting material and labor ranges from seven to ten dollars per acre.

Growing the Little Trees.—The raising of the little trees for setting out in artificial forests is a very interesting business and one that is receiving more and more attention in this country. Wild seedlings have been tried both in Europe and in the United States, but owing to the fact that they generally start their life in rather compact soil their root systems are far smaller than those raised in well worked and highly fertilized seed beds. Small root systems mean poor resistance to drought or insufficient food supply; hence artificially raised seedlings have proven far superior.

For raising these seedlings a level fertile field, one that has been tilled and well fertilized for years, is desirable. An old garden would be ideal, but it is apt to contain spores of the "damping-off fungus," a disease

which causes the tiny seedlings to wither just above the ground and is extremely fatal.

Hardwood forests are started by planting the seed in long drills and the next spring these year-old seedlings are planted in the field. Nut-bearing varieties may be started directly in the field by punching a hole with a cane and inserting the nut where the tree is wanted, the chief difficulty in this case being that hungry squirrels may follow along the lines and eat up nearly all of the buried nuts. By far the largest amount of planting is done with evergreen species on account of the value of the timber and the ease with which the little trees can be raised and planted. Hence a description of how pines and spruces are grown will be more interesting.

Having selected the site with plenty of water available, beds are made ordinarily four feet wide and from twelve to one hundred feet long. A bed four by twelve feet was used almost entirely by the early nurserymen, so it will be used as the unit of measure for amount of fertilizer, seed, etc.

The ground must first be well pulverized and a couple of barrels of well rotted leaves and the same amount of old manure to each bed is spaded in and thoroughly mixed with the soil. Plants are like boys, and if they are to make fast growth they must be well fed.

The beds are then made, being slightly raised above the ground and with the center a little higher than the sides. This is to insure drainage, for the little trees cannot stand wet feet. In some commercial nurseries each bed is surrounded by a wire screen to keep out the birds and squirrels.

After the bed is made it is sown with from six to ten ounces of seed, depending upon the species. Ordi-

narily it is planned to scatter from six hundred to one thousand seeds to each square foot, depending upon the fertility of the seed. The bed has been thoroughly soaked before the seed was scattered and now that the seed is evenly distributed it must be covered with a thin layer of sterile soil which does not contain any spores of the damping-off fungus. Old garden soil is usually pretty well inoculated with this disease, so it is better to dig down into the ground two to three feet and get some soil that has not seen daylight for centuries. This is apt to be free from any organisms and if sprinkled evenly over the bed by being passed through a sieve the fatal disease may be avoided. The spores germinate in the very surface of the bed and hence it is the surface soil which is most important. The beds are then covered with a leaf mulch or burlap to keep the light out and the moisture in and the cover is ordinarily retained from two to three weeks.

After germination starts the covering must be removed immediately or the little trees will smother or perish from lack of sunlight. However, too much light is dangerous, as they are quite delicate at first, so ordinarily a screen, made by nailing lath one and a half inches apart upon thin strips, is kept over them continually.

Weeds must be removed during this first season and the beds must be sprinkled from time to time if rainfall is scanty. The plan is to provide plenty of plant food and moisture and thereby grow a stocky plant with a fibrous root system in as little time as possible. On damp and cloudy days the screen is removed gradually to harden the plants and get them accustomed to full sunlight.

About the latter part of August weeding is stopped,

since to disturb the ground further might cause freezing of the roots. With the first fall of snow a strip of burlap or a layer of leaves is placed upon the seed bed and thus they remain safe and snug during the cold weather.

The second season is similar to the first except that less care is needed. The plants are quite dense now—there may be from two to four hundred per square foot—and their tops form a dense mat. A little weeding and watering is all that is necessary to carry them through this summer and by the second autumn they are so hardy that no covering is required.

Field Planting.—The next spring when the plants are two years old they are ready to be planted or if extra hardy trees are wanted they must be put out in a transplant bed. Since large roots rather than large tops are needed, a year or two in the transplant beds is very beneficial. In these beds the little trees are placed in rows from twelve to fifteen inches apart and are spaced from two to three inches apart in the rows. On account of the increased growing space allotted to each plant in the transplant bed a good root system is developed. The trees remain in this bed from one to two years, depending upon the size of the material needed.

For planting in open fields where neither the sod nor weeds are too thick a two-year coniferous seedling will grow, but if the weeds are rank growing or if the ground is heavily shaded by brush or trees the three- or four-year-old transplant must be used for a successful plantation.

The choice of planting stock depends upon the climate, for species native to the region should be preferred; upon the market needs, for species should be

chosen with an eye to their salability and finally upon the type of soil to be planted.

Hardwoods, especially tap-rooted species, require deep, fertile, well drained soil for good growth. Conifers draw less upon the fertility and moisture contents of the soil than do broadleaf trees. Among conifers, however, there is a marked difference, as red and jack pine can grow on dry sandy soils where spruce and hemlock would soon perish.

When the frost is out of the ground is usually the best time for planting although if the ground is not subject to heaving in the spring, fall planting may be practiced. The seedlings and transplants are dug from the beds with a fork, tied in bundles and packed in large hampers with wet moss around their roots and in this condition are shipped to the area to be planted.

On arrival the bundles are loosened, the roots dipped in a puddle of thin mud and then the bundles are laid on the side of a sloping trench with earth firmly packed about their roots. This process is called "heeling in" and is intended to keep the delicate root hairs from drying out.

The planting crew consists of two men as a unit, one carrying a mattock with which he slices off the sod and digs the hole, the second man carrying a pail with several inches of thin mud in the bottom to keep the little tree roots constantly moist. Back and forth across the field they go, the row of mattock men keeping themselves in a straight line by sighting on a rock or stump some distance ahead. Behind them come the bucket men putting the tree in the hole and firming the soil around the roots first with their fists and later with their feet. The two most important points to remember are that the roots must not be allowed to dry out and

that the earth must be tightly packed around the little tree.

Six feet apart the trees are planted and ordinarily a planting crew can cover from two-thirds to a little over an acre a day, depending on the toughness of the soil and its freedom from stones.

If good planting stock has been used and if the ground was firmly pressed around the roots eighty-five or ninety per cent of the little trees should be alive at the end of the first season. An excessively dry summer, or careless planting, may cause high mortality.

Costs and Results.—Forest planting is considered a good investment and like every other phase of forestry must pay its way financially. Land that can be tilled should not be planted unless as a landscape improvement. If cheap land is planted and the whole cost including purchase of land and planting expenses—seven to ten dollars per acre—does not exceed fifteen dollars per acre, the investment should certainly yield four or five per cent compound interest based on present stumpage value. With the increase in timber values that is bound to occur as the result of our diminishing timber supply even a higher rate should be assured. The element of time, however, is discouraging to many persons, but the Federal Government, States, railroads, and other corporations and logging companies with continuous existence can plant and feel that a good long-time investment has been made.

Even private individuals who from sentimental or business reasons possess land, a part of which is unsuited to agriculture will find enormous satisfaction in watching a young plantation develop, feeling all the while that they have made an investment for their descendants. The pleasure derived from watching things grow

from seed to maturity is a natural sentiment old as the human race and to plant a tree with its long lease of life is to confer a boon upon humanity. In the words of the poet, "He who plants a tree plants a hope."

CHAPTER VII

THE LIFE OF A FORESTER

WHAT does a forester really do and under what circumstances does he live? This and kindred questions have been asked by countless boys since forestry became a recognized profession in this country. Many boys believe that a forester's life is one grand round of hunting and fishing and do not appreciate the strenuous work and the occasional hardships that are a part of the game. Any profession or business contains unpleasant tasks but to a young man fond of the open, not afraid of responsibility and hard work there are few professions which offer the opportunities for such a useful life spent in pleasant surroundings. Its members, however, while serving the State or nation have little chance of dying disgracefully rich.

In choosing one's life work, the questions naturally arise: Am I fitted for this profession? What course of preparation must I pursue, and what are the duties and opportunities ahead of me after I have completed my training? These are all serious questions which should be answered before embarking upon a career, and it is especially desirable in the case of a young man thinking of taking up forestry. As Gifford Pinchot says, in his admirable book "The Training of a Forester": "To the man not fully adapted for it, forestry must be punishment, pure and simple."

What then are the qualifications, the attributes,

Courtesy Canadian Northern R. R.

MAKING CAMP FOR THE NIGHT

The ability to shift for himself under all conditions is absolutely necessary to a forester. To travel the woods, handle a canoe, cook, etc., are all part of the game.

needed to succeed in this profession? First of all, a sound body is absolutely indispensable. Many young men have considered taking up forestry thinking it a profession suited to them because they were undeveloped or had weak lungs. Therein they make a great mistake, for a forester's life is too hard for a semi-invalid.

Regarding mental qualifications, openness of mind and powers of observation are especially necessary because new problems are constantly arising which require immediate solution. Both a good physique and a good head are needed, for while the life is too severe for a weakling, it is equally true that the forestry vocation holds forth little hope to the man with a strong back and a weak head.

The administrative phase of a forester's life demands executive ability of a high order and in addition to the power of commanding others, tact, sympathy and human understanding are required. The striking success attained by the Eastern trained forester in managing the national forests in the West is simply another bit of evidence testifying to adaptability and horse sense of the average young American. He has frequently been called upon to decide upon cattle problems or to answer questions upon subjects in which his school training gave him no aid but his adaptability and his willingness to look at things from the other fellow's point of view in most cases have brought him through with flying colors.

Preparation in College.—So much for the life in general. Now what course of study is expected of the young man preparing himself to be a forester? At present there are two distinct lines of work in forestry education: first, the forestry course proper, which requires from five to six years of stiff work in a college or school of forestry;

and second, a one-year course of practical training in a ranger school. The latter course while not really leading to a forestry degree is mentioned because while it only prepares men for subordinate positions like woods foremen, forest rangers, guards, etc., it has been considered by some as a short cut to a forester's diploma. It is as true now as in the days of Euclid, that there is no short or "royal road to learning."

The ranger courses now offered at several schools in the United States are intensely practical. Ordinarily a strong body and a grammar-school education are sufficient. The rudiments of surveying, silviculture (the science of tending the forest), dendrology (the study of trees) are taught and much stress is laid on the practical phases of lumbering, timber cruising, fire protection, road and trail construction, etc. Trained forest rangers and guards will be in great demand in the country but no young man should consider that one year in a ranger school will make him a forester. He will always remain a subordinate, a valuable man, but one with limited responsibility, and will doubtless spend the bulk of his time in the woods.

The regular forestry course is something entirely different. It may be taken as a two-year postgraduate course after completing a regular four-year college course, or a continuous five-year course may be taken in which, by specializing in sciences, like botany, dendrology, and silviculture, during the first two years, one year is saved.

A forester to go far in his profession should have a broad education. He should have a good command of English and preferably should be able to read German and French, since many forest problems have been worked out by the European foresters. He should be

well posted in history and economics, for if he is to occupy an executive position he should possess broad vision. Mathematics of course is needed preparatory to surveying; chemistry is required in order that the process of plant physiology may be understood. Botany and dendrology are of course essential, for a forester must know his trees and shrubs and how they grow. A thorough knowledge of geology, the structure of rocks, the soils they make when they are weathered down by the elements, is of course indispensable. Finally, a forester must be familiar with the signs of insect attack and fungus diseases. The forester in charge of a valuable timber tract noticing such attacks in their early stages may be able to prevent enormous financial loss.

After these preliminary subjects have been completed, advanced courses are taken in such subjects as forest protection, forest engineering—including map-making, road and trail construction—and forest mensuration—the measuring of the forest crop, etc. Lumbering and forest utilization are also covered and finally the science of forest management is pursued, which deals with the handling of a piece of forest property in a business-like way; the latter subject includes the financial aspects of forestry, and the regulation of the forest yield. It will be seen that the field is broad and the time spent in college is none too long to secure a thorough training in these important subjects.

Need of Practical Training.—To train graduates successfully a forestry school must be thorough and must provide an abundance of practical work. In hardly any profession, with the possible exception of medicine, is a book-taught man with little practical expe-

rience as useless or dangerous as in forestry. Most schools require a large amount of laboratory and field work and many institutions are now insisting that at least one summer vacation shall be given over to three months of practical work in a field camp under the supervision of instructors. Here additional experience in surveying, the running of old boundary lines, timber cruising and map-making on a large scale are obtained. It goes without saying that the better the practical training the more valuable will the student be to his employer. After five or six years of thorough training in college the young forester is ready to try his wings, but he should consider himself no more than an apprentice, familiar with his tools but by no means an expert. Several years of experience with gradually increasing responsibility are necessary before he can really consider himself a forester.

Several lines of work are open to the forestry graduate at the present time. In the past the National Forest Service has been the chief employer of technical foresters but at present this demand is decreasing and other openings are appearing with lumber companies, railroads, estate owners, State forest departments, etc. Whichever line of work is chosen, the possibilities ahead should be carefully investigated and a man with real talent for a certain line of work should specialize along that line, for the day of the specialist in forestry has arrived.

Men fond of research can specialize in problems dealing with the life habits of trees, forest entomology, the study of insects attacking the forest, or the chemistry of forest products, etc. Men interested in the commercial end may take up paper-making or fit themselves to be expert lumber salesmen, while those fond

of broad administrative work can enter Government or State service or become logging engineers. It is undoubtedly true that the demand for the type of forester which has been turned out in the past has diminished, but there is no reason why a man with a good mind thoroughly trained should have any difficulty in making a good living in one of the various phases of forestry which are now developing.

The popular notion is, however, that the real forester is the man in charge of the forest itself, and so he is. The laboratory specialist in forest products is the man of the future, the possibility of tomorrow; the forester of today is the silviculturist, the man who tends the forest; his is the life of charm and ever-changing interest.

The Forester's Duties.—After the student has completed his five or six years' course he may desire to enter the Government or a State Forest Service. To obtain such an appointment it is necessary to pass a stiff examination to become eligible. If the candidate be successful and he is admitted to the Federal Forest Service as a forest assistant, he will receive $1100 per year. He may be assigned to one of the seven districts into which the Forest Service divides the National Forests. Upon reporting to headquarters he is assigned to a particular forest where he will help the forest supervisor in charge in any way possible. If a surveying party is in the field, he may join it and remain surveying and estimating timber until he becomes accustomed to the country and types of timber, and becomes familiar with the local problems. Whatever work he is assigned to, his responsibility at first will not be heavy.

If he has been placed upon a forest where a timber

sale is in progress his duties are varied and may range from marking trees for removal ahead of future timber sales, to scaling logs or inspecting the piling of brush. He learns to lay out trails, string telephone lines, becomes familiar with the grazing problems of that particular forest and endeavors to distinguish the several score of cattle marks and brands that are found on his own range. In whatever he attempts he is usually guided and taught by an experienced ranger for when all is said and done the rangers are the mentors of the youthful forester.

Stewart Edward White in his "California John" stories has described a splendid type of ranger and at the same time has painted a striking picture of conditions as they existed in the early days before the Forest Service was transferred from the Department of the Interior. The forest rangers are splendid men, simple in manner, kindly in speech, and the young forest assistant who tries to lord it over one of them regrets it. He soon learns how little his book knowledge weighs against a lifetime of experience when it comes to packing a horse or making a trail. Each can profit from the other and it is the wise young college chap who knows at the start that when it comes to valuable information he can get more than he can give. Many stories are told about the breaks made by the green young forester in the West and sometimes their greenness and conceit has led them into dangers from which they have been rescued only by the rangers or local ranchmen.

After the young forester has learned to distinguish the various trees on his forest—for trees on the ground or standing upon the mountainside may not resemble the trees which his textbook described—he has just made

a beginning. He has yet to learn the laws under which mining claims and forest homesteads may be located, the routine of timber sales and the ins and outs of the cattle business and when finally he has mastered the business routine and the forms of the supervisor's office he commences to be useful, for previously he was a mere apprentice. From this time on more responsibility is shifted upon his shoulders. He may take charge of the office and try his hand at running the forest for a week or two at a time while his chief is in the field inspecting timber sales or fire protection work. When it is realized that the average unit of forest administration, the National Forest, is 1,000,000 acres against 10,000 acres in Germany and that there is one employee for each 125,000 acres in the United States against one forest guard for every two hundred acres in German forests, some conception of the man-size job may be obtained. It is only by the exercise of marvelous ingenuity that the Forest Service has been able to protect the nation's woodlot as well as it has in view of its meager appropriations and limited number of employees. The very battle against odds has instilled in men of the Forest Service a feeling of comradeship, an *esprit de corps* which is largely responsible for the outcome. The winning of the West, the success in changing the feelings of the cattlemen and lumbermen from open hostility to genuine friendship is a striking example of good administration on a gigantic scale.

If the young forest assistant instead of being assigned to a forest had been placed in a reconnaissance party his lot would not have been quite so varied but even more strenuous, for life in a reconnaissance camp is one of stirring activity. In some of the dis-

tricts the Land Office surveys have not been completed so if a classification of the land is desired a survey must first be made. The reconnaissance crew by means of transit and chain lay off the unmapped regions into townships six miles square, each township being later subdivided into thirty-six sections each of which is again divided into four quarter-sections of one hundred and sixty acres each and a map of the timber made while the lines are being run.

As described in the first chapter, most of Uncle Sam's holdings are far back in the mountains, the best timber land having been acquired by the far-sighted lumberman, so that life in a survey party may be rather solitary. The high elevations make the air invigorating but frosty and the men come out of the mountains at the end of the summer in perfect physical condition.

In some forests a large amount of timber estimating is done in the wintertime. Ordinarily the activities of the forests slacken up at that season and if the ground is extremely brushy a snow cover makes winter travel much easier. In the mountains of California where winter reconnaissance has been tried the results have been quite good. The snowfall is very heavy and drifts form of almost unbelievable depths—forty to fifty feet is the depth ascribed to some drifts. Snowshoes or skees of course are necessary and fast time can be make as long as the snow crust is hard, but woe betide the forester if he loses his shoe and falls, for a good floundering time is ahead of him.

In practically any phase of work in the Forest Service hard physical work is the rule but the pleasure of life in the open, the invigorating mountain air, the occasional hunting and fishing trips—not so frequent as are imagined—give zest to the life and make the

members of the service a healthy, happy body of young men.

In State work different problems are met, and the management of citizens rather than forests constitutes the problem. Fourteen States own forests containing altogether 3,426,000 acres but the management of the forests is ordinarily of less importance than molding the minds of the citizens. When it is realized that four-fifths of all the timber in the United States is owned by private individuals, the need of popular education along foresty lines is seen. The private owner must be convinced that the practice of forestry or at least conservative lumbering and close utilization are feasible. The private citizen must be taught that forests are indispensable, not only for the timber that they produce but also because of their effects on climate and water supply. When the people of a given State realize these things, laws favorable to the forest owner will be passed, forests will be more safe from fires, less subject to unjust taxation and the business of producing forest products of all kinds will be on a firmer basis.

As a rule a different type of man is required in State forest work. If the State owns forest land and sells timber from it, his work will be largely the same as in the Federal Service. In most States, however, he must be a forestry evangelist who will preach the gospel of better forestry to the private landowners within his territory. His knowledge must be fully as great and in addition he must be enthusiastic, a good mixer and able to speak with conviction. The average position with a State department requires a maximum of general knowledge, and tact and judgment as well.

With lumber companies at present, a forester's job

is largely one of forest inspector. He runs out the boundary lines with a compass; he estimates and maps the timber, showing where patches of fire or insect-killed timber are located in order that they may be immediately removed. He lays out the road system for the logging job and selects the camp sites. He estimates the growth of the timber and how much can be cut annually and forever, or if they are cutting beyond their growth, how long their supply will last. He marks the timber ahead of the choppers, supervises the piling of brush, enforces close utilization—low stumps, and cutting the logs far into the crowns. These are some of the duties likely to fall upon the shoulders of men employed by lumbermen. In some quarters it is claimed that foresters have not been worth their salt to lumbermen in the past. The trouble may have lain between them both. Either the lumberman did not know what he could expect of his technically trained man or the forester may have been slow to develop new lines of work. Many of the paper companies of the East are now employing foresters and find that the map system alone, showing the present stand of timber, and the site of previous cuttings, the general topography of their holdings, is worth the salary of the forester for many years. In one instance a forester by locating an insect attack on one of his cruising trips and by insisting that the logging boss cut the infected timber at once, finally succeeded in saving over $100,000 worth of timber and this prompt action prevented a further spread of the pest.

Upon a private estate a forester's life depends upon circumstances. If it is a large forest area from 10,000 acres up, he may have use for his technical training in supervising the logging operation or

planting of waste land. If, however, the estate is small and no cutting is done, his work may be more of a landscape gardener and gamekeeper combined. On all estates, the forester is likely to have charge of the protection and propagation of game, and already one forest school is giving a course in fish and game protection. In Germany and France protecting the game and selling hunting privileges of the forest in his charge is as much a part of the forester's work as is the selling of timber. It will be only a short time before the same custom will prevail in this country and foresters will be required to know the habits, food and cover required by all the denizens of our forests.

From the foregoing description it can be seen that the forester's life is many sided. It is rich in possibilities, even though not especially well paid; in fact it is a profession in which a large part of the payment consists in an enjoyable life and the satisfaction which comes from feeling that one is serving the State or nation by aiding in solving the problem of what to do with non-agricultural land. Forestry is a unique vocation; it makes severe demands upon its members yet it yields countless compensations.

With plenty of responsibility and opportunity for splendid pioneer work the life of a forester is one that appeals to young men with red blood. It is safe to say that the ideals held by the men of the United States Forest Service are not surpassed by those of any profession and their love of and pride in their work, their companionship, their *esprit de corps* is a magnificent tribute to Pinchot, Price, and Graves, and their associates. The nation owes a heavy debt to them, not alone for the efficient management of the nation's forests but for the lofty standards of public

Courtesy U. S. Forest Service

THE START OF THE PACK TRAIN

On many of the National Forests the pack outfit must be used to transport a large amount of the supplies, since the roughness of the country may make wagon roads out of the question.

service which they have established. Considering the manifold activities and lines of work open to a forester the lure is strong; yet it is a calling for only the elect.

Mr. Pinchot advises men to keep out of it if they can, believing that the misfit is unhappier in this than in any other profession. The men who have answered the call of the Red Gods in the past have been largely active, full-blooded fellows whom no salary could keep in an office. In the future forestry will doubtless offer various opportunities to different types of men: to the man fond of research, to the salesman, to the logging engineer, and the forest administrator but no man should enter the profession, however, thinking to find an easy berth. It will always call forth the best there is in Young America and one who is afraid of manual labor, of putting in at least several years of apprenticeship in either laboratory, sawmill, or lumberyard, had better keep out.

To the man who is fond of administrative work and who relishes the pleasure of working side by side with men of high ideals who glory in their work, forestry offers splendid opportunities. The feeling also that one is working for future generations, for Americans yet unborn, is very inspiring. This recalls a story told about Johann von Schiller, Germany's great poet. While visiting a forester in the Thuringen Wald he found in his friend's study one day a map of his forest showing the cuttings that would be made during the next two hundred and twenty years. When Schiller realized the extent and perfection of these plans he said, "You foresters work quietly and entirely free from hopes of reward while the fruits of your work ripen for a late posterity. Hero and poet attain a vain glory.

I would like to be a forester." It is as true today as then that the forester works quietly and with slight recompense but few lives hold forth such promise of richness, fullness, and opportunity for service as does the life of a forester.

CHAPTER VIII

HOW THE FOREST IS GUARDED

FORESTS like any other communities are subject to attacks which cause their numbers to decrease, and the forester like the health commissioner in any city must be on guard to prevent any unnecessary deaths in the forest community.

During youth when each tree is struggling against its neighbors for light and plant food, the mortality is rather high, but this may be considered an ordinary condition as usually more trees start to grow than the land can support. In addition to these heavy losses during the early years, forests may be attacked from time to time by a variety of injurious agencies which, while not always preventable are rather abnormal. The most common of these agencies are fire, insects, fungi, wind, ice and snow. Of all these enemies fire by all odds causes the most damage.

Fire Fighting.—When it is realized that since the settlement of this country more timber has been cut and burned than is now standing, some idea of the forest products consumed may be gained, and it is safe to say that as much has been burned as has been used. The loss due to forest fires has been estimated by the United States Forest Service as $50,000,000 per year. The pity of it is that at least seventy per cent of this enormous loss is caused by fires that are preventable.

Forest fires are not entirely a product of the white man's civilization, for investigations in the West have

shown that fires caused by lightning or set by Indian hunters to drive out game swept over the mountains again and again long before white men settled on the Atlantic Coast. In fact, the vast stretches of lodgepole pine in northern Colorado are believed to be the result of these early fires, as this species finds ideal conditions for germination and growth after the forest soil has been heavily burned.

It is only within the past few years that an organized effort has been made to prevent and check forest fires. Formerly they were regarded as an act of Providence and the advancing flames were fought only when they approached a village. Otherwise the fires were generally allowed to burn until the wind changed or a general rain made the forest too wet to burn. Within late years and largely as the result of fire-fighting experience by the foresters of the country, lumbermen have learned that forest fires are largely preventable, and under ordinary circumstances can be extinguished if attacked at once. As a consequence in addition to the fire-fighting force of patrolmen, forest guards, and lookout men, maintained by the National Forest Service and many of the States, protective associations are now being formed by lumbermen to reduce their fire risk.

Forest fires may be divided into three classes: First, those that burn along the surface of the ground, called surface fires; second, those that burn in the duff or layer of vegetable mold on top of the mineral soil—ground fires; and third, the crown fire which burns from tree to tree with the head of the fire up in the treetops and the widespread wings trailing down upon the ground.

Surface fires are the most common and least danger-

ous, for while they consume the seed which has fallen and the little seedlings and may even kill some of the thin-barked saplings, they do not as a rule kill merchantable timber. All of their results, however, are not visible immediately. Many a woodlot which has been swept by a severe ground fire may, four or five years later exhibit a very large number of trees affected with fungus diseases just above the ground. The trees really were damaged at the time of the fire but did not show it until later. Even though the trees may not be severely damaged the fire consumes the litter and leaf mold which should have enriched the soil and as a consequence growth will be seriously checked. On cutting down a tree the scars of an old fire may be seen towards the center of the tree and it is quite common to note that the annual growth rings have diminished in width after the fire, owing to the burning up of the food supply stored up in the humus.

Surface fires are most common in the spring and fall and if the ground beneath is damp only the loose leaves on top will be consumed. In the regions where the long winters and short cool summers cause a thick accumulation of leaf mold or duff, this layer may take fire and the ground fire thus started may assume serious proportions. In such cases it may smolder along beneath the surface of the peaty layer, burning off the roots of the trees until the first strong wind will pile them up like jackstraws. If the duff is particularly thick a ground fire may smolder for months.

A crown fire is a calamity hard to appreciate, and to see or hear one is an experience never to be forgotten. Crown fires occur only during extremely dry seasons and in dense coniferous stands where the trees are very close together. The start of a crown fire occurs

as follows: A surface fire that is running through the woods suddenly strikes a resinous tree, a balsam for example or one with an unusually low hanging crown. It runs up the inflammable tree and in a second the entire crown is ablaze. The draft created carries the flames to adjoining trees and in a few minutes the fire is roaring away fanned by its own draft. The fire burns ahead like a huge V, the point advancing rapidly in the crowns, the wings trailing lower down and finally reaching the ground. New fires are started ahead of the main blaze by brands of blazing bark thrown by the terrific gale. Up the slope the fire rushes furiously, pauses at the crest and then slowly burns down the other side of the mountain. Before a high gale great speed is attained and woe to the unlucky hunter or fire fighter who is caught in the track of such a blaze. On steep slopes or in country covered with brush or the débris from old lumbering jobs it may be impossible to escape especially if there is a strong wind blowing.

Fire fighting is by all odds the most dangerous and laborious work a forester has to perform. It means long hours of trenching or work with the ax and saw, terrific heat, thirst, and fatigue, and always with the chance of being surrounded by the flames. Tales of heroism are told of fire fighters that make the heart thrill as truly as do the stories of courage in battle. In the summer of 1910 when the whole West was covered with a dense pall of smoke from a thousand fires, over seventy fire fighters were known to have lost their lives. That the toll of the fire was not greater is largely due to the coolness and presence of mind of the men in the Forest Service. One of the most heroic stories told is that of Edward C. Pulaski, forest ranger of Wallace,

Idaho. Cut off by the flames with his band of fifty men, chiefly foreigners, his knowledge of the country enabled him to lead them to an abandoned mine tunnel. Placing a wet blanket over the tunnel mouth to keep out the smoke, Ranger Pulaski with drawn revolver kept the fire fighters, half-crazed with fear, from rushing out into the flames. One man did make his escape only to perish. The remainder, owing to the great courage of their leader, came through with little injury, although he, owing to his position at the mouth of the tunnel, suffered serious burns from which he did not recover for months.

Fire fighting on a large scale is much like real warfare. An army of men must be mobilized and dispatched to the front. They must be divided into squads under the command of an experienced man and remain subject to his control. Weapons, in this case, picks, shovels, mattocks, saws, axes, etc., must be furnished. Blankets and camp equipment must be brought in and food and water must be supplied to the men on the firing line. In the big fire in southern Idaho in August, 1914, over one thousand men were on the line at one time, and to keep up the fighting efficiency of this regiment, one hundred miles from the nearest railroad, required a systematic organization closely resembling those employed in army maneuvers. Automobile trucks and pack trains moved in a continuous procession from the railroad to the commissary on the line, for men to fight fire must be well fed.

When a fire has gotten into the crowns and goes rushing away cross country from ten to twelve miles an hour there is little that can be done in the daytime. For while the sun is hot, the fire burns fiercely, and even if there is no wind the suction created by the

flames themselves creates a draft and sends firebrands and blazing bits of bark whirling ahead many rods to set new fires ahead of the advancing front. Close approach to the fire is out of the question, and only by clearing a wide strip far ahead of the fire and "back firing" can the crown fires be stopped. The idea in back firing is to start a small fire on the edge of a cleared strip which is permitted and encouraged to burn against the wind toward the advancing blaze. The fire line, of course, is carefully guarded by a line of men to prevent this fire from leaping over it and burning the timber it is desired to save. As the back fire burns, of course, it consumes all brush and inflammable material and leaves nothing for the main fire to feed upon. As the two fires approach a terrific draft is created and the two flames rush to meet each other with a loud roar and after burning fiercely for a time, gradually die out. The front of the fire having been disposed of, the ground fire left burning is then taken care of. In some cases where a crown fire has assumed large proportions owing to high winds and long drought, human aid is futile; only rain or a change in wind to drive the flames back upon the burned-over area can quench the blaze.

Fighting a ground or surface fire, while laborious, is not so dangerous, as the fire makes headway slowly. Different methods of fighting are used depending on the ground cover, soil, topography, and water supply. In the Adirondacks a ground fire must be fought by cutting a trench around it, as the deep layer of humus burns like peat. In rocky soil dynamite may be used to dig this trench far better than men with mattocks and shovels. In case of a surface fire where only the light litter is burning, a cedar brush or wet burlap bag may be used to beat out the fire, but care must be taken

that in beating out the flames no burning leaves, etc., are thrown ahead of the fire to start a new blaze. Where the soil is sandy as on Long Island, New York, and on Cape Cod in Massachusetts, shovels and rakes are excellent fire-fighting tools, and the fire is controlled by throwing sand upon it. Certain towns in Massachusetts have regular fire wagons with portable fire extinguishers. These, of course, can be used only on level country and where more water can be obtained to recharge the extinguishers. It is claimed that one of these portable extinguishers will put out two hundred feet of blazing scrub oak.

Whatever type of fire is fought, men should always be left to guard it until it is known to be out positively. Some of the most disastrous fires known have resulted from blazes that were thought to be under control and afterward started up again. Even though entirely surrounded by a fire line or trench a smoldering stub or log may be fanned into flame by the next morning's breeze. The breeze increases, the flames roar up some tinder-dry old snag, and finally, a brand is carried over the fire line and a new fire starts. In some cases where the soil and duff are extremely dry, it may be necessary to keep several men patrolling the fire line for weeks, but this is far cheaper and better than bringing out a hundred men to fight the fire all over again.

As stated in the early part of this chapter a large portion of this enormous fire damage could be avoided, for a majority of the fires are set through carelessness. The most frequent causes are the following: sportsmen, by carelessly throwing down a match or lighted cigar, or by failing to put out their camp fires; settlers, by clearing fields and permitting the brush fires to get away from them, and railroad engines, by throwing out

Courtesy U. S. Forest Service

RESULTS OF A CROWN FIRE IN NORTHERN IDAHO

The damage inflicted by a forest fire far exceeds the amount of mature timber killed. The seedlings and seed upon the ground are destroyed, and it may take many years to reclothe these mountain slopes with a complete forest cover.

sparks along the track. Lightning sets some fires, especially in the West where electrical storms with little or no rain are common. Such a storm set no less than eighteen fires one Sunday afternoon on a National Forest in northern Idaho.

How to Prevent Fires.—The best way to decrease the number of forest fires and diminish the enormous annual loss—$50,000,000—is to educate the American people concerning the danger that is incurred as the result of carelessness in the woods. Everyone going into the forest should realize that he should not leave his campfire without pouring water upon it. A safe plan is to build the fire on the stony edge of a brook or if that is impossible, to rake away leaves and rotten limbs that might smolder unnoticed.

Next in importance to public education is the building up by the States of a fire protection force composed of lookout men, patrolmen, and rangers. Great strides have been made in the science of fire fighting during the last few years. Speed in the reaching of a fire is absolutely necessary and that is where the mountain lookout station is of such great service. These lookout stations, which are used by the Federal Forest Service and many of the States, are located on the highest mountain peaks, points that command a superb view of many square miles of forest-covered territory. Sometimes it is only a little hut on top of the mountain while in other cases a steel frame like a windmill tower is built and a one-room shack built on top of this. Here the lookout man remains during the fire season, a map of the region spread on the table before him and a strong pair of field-glasses in his hand. If he notices a thread of smoke arising from a neighboring valley he reaches for the telephone and notifies the

ranger in charge of that district and tells him as well as he can just where the fire is. The ranger collects a man or two and immediately starts to the fire to put it out before it has obtained any headway. The old adage, "A stitch in time saves nine," is doubly true regarding fire fighting for several men can extinguish a fire within an hour or two of its beginning that a regiment could not hold after a day or two.

The most up-to-date fire-fighting organizations have regular war maps. The district in charge of a superintendent is divided into sub-districts each in charge of a district ranger. Every square mile of territory is mapped to show where the danger spots are, the character of the country, the best way to get in, where men can be collected and other points of value. Thus when a fire is located a glance at the map shows all necessary details.

While such organization is necessary under present conditions, with increasing knowledge our forests should be as safe as those upon the continent. A story is told of an American who was visiting a German forest who asked his guide if they ever had any forest fires. "Oh no," said the forester. Then after a moment's thought he said, "I'll take that back; we did have *one* here two hundred years ago." The future of American forests and their safety from fires is largely in the hands of the boys who are now growing to manhood.

Other Enemies of the Forest.—Other kinds of injury to which a forest is subject are those due to insects, fungus disease, and wind and ice storms. These, however, are not so noticeable nor is there prevention or suppression in which the help of the general public is possible. In certain parts of the country, however, the Boy Scouts have been of great service in destroying the

egg masses of the leaf-eating beetles or destroying broods of the tent caterpillars.

Insects.—While the effects of insects are not often heard of, nevertheless, year in and year out an enormous amount of damage is done to our forests and shade trees by these winged pests. In the seventies the larch sawfly threatened to exterminate this valuable timber tree from our Northern forests. The spruce bark beetle has taken a heavy toll from time to time in the New England States; the Western pine beetle for several years threatened the splendid yellow pine stands of the Black Hills. Even now we hear of the white pine weevil and its destructive effect upon young pine plantations; the ravages of the elm leaf beetle and the enormous loss caused, largely in the New England States, by the gypsy and brown-tail moths.

Remedies for these agencies are not always easy to discover. Bark beetles can best be exterminated by felling the trees and burning the bark or else soaking the infected logs in a stream. This can be done quite readily where the logs are ordinarily floated to the mill, by timing the cutting according to the development of the insect.

For the white pine weevil several cures are suggested. Cutting and burning the withered leaders of the young pine trees during June will kill the grubs but at the same time it may kill some parasities which have been preying upon the larvæ. The latest remedy suggested is to cut off the leader which is dying and by putting it in a barrel covered with a fine screen, the parasites can escape, and will prey further upon the pest.

Suppression of the gypsy and brown-tail moths is a job that the New England States assisted by the National Government are finding well-nigh impossible.

Brought over from Europe for experiment purposes about forty years ago they escaped by accident and were not heard of for some time. When their activities near Boston were noticed an appropriation was made for a few years but against the recommendations of experts this appropriation was discontinued for about five years because they appeared to be extinct. In reality two or three years' more work would have exterminated them completely. With the cessation of preventive measures the moths increased rapidly and as a consequence they spread from Massachusetts to practically all of the New England States. In Massachusetts alone nearly $1,000,000 per year is spent by the State, Federal Government, and private individuals to control these destructive insects.

Leaf-eaters like the larvæ of the gypsy and browntail moths, the elm leaf beetle, etc., can be killed by poisoning their food. A solution of lead arsenate is sprayed upon the leaves and the caterpillars die by the thousand after eating the leaves. However, the difficulty and expense of spraying thousands of acres of woodland is at once apparent and unless the natural enemies multiply and can take care of a large part of the annual crop of these pests, neighboring States must certainly be invaded by hungry armies of insects. By creosoting the egg masses, by removing trees to which they are especially partial and by breeding and liberating parasites it is hoped to keep them in check.

Fungi.—The harmful effects of fungus disease are noticed both on living and dead timber. Those found on dead timber are called "saprophytes" and are not especially dangerous. Of the parasitic fungi—those that attack living trees—one of most importance at present is the chestnut bark disease—*Endothea para-*

sitica. The spores of this fungus are carried by wind or upon the feet of birds and finding lodgment in a wound in the bark of a chestnut, start to grow. The fungus develops in the inner bark and kills the tree by girdling it, thus cutting off the sap supply. No remedy for this disease has yet been found and although it is not spreading as rapidly as when it was discovered in 1905, it is still killing this valuable species in large numbers. The total loss at present has been estimated to be in excess of $25,000,000.

Another fungus disease which was imported from Europe is the white pine blister rust which attacks small pine trees. This fungus has caused much trouble but is believed to be under control. It passes part of its existence upon the currant and gooseberry and if all the infected pines are torn out and burned and the same treatment is administered to the berry bushes within three or four hundred feet of the plantation the remainder is likely to be safe.

The influence of the saprophytic fungi—those that attack only dead trees and timber—must really be considered beneficial, for it is owing to their action that the trees and plants are so soon gotten out of the way and their substance is again returned to the earth to nourish the next generation of trees.

As in a community of people, the loss in a forest is greatest in childhood, least during middle life, and then gradually increases with age. A forest is continually fighting against these agencies and when we realize how the various tree species have survived throughout the countless centuries, the marvelous structure of a tree with its ability to resist and overcome these many agencies becomes apparent. We realize that the tree bears the same relation to the

vegetable, as man does to the animal, kingdom; the highest, the most perfect of its type.

Wind, Ice and Snow.—Of wind, ice, and frost much could be said. Shallow-rooted species like spruce and lodgepole pine of the Rockies are very subject to wind throw. Snow or sleet storms may cause great damage especially in young stands by bending and breaking the leaders and branches, thus ruining the shape of the tree or at least making fungus infection through broken limbs quite probable. During frosty nights trees may crack open owing to unequal contraction of wood and bark and these "frost ribs" reduce the value of the lumber.

Wind, while a friend of the forest and a great help in assisting trees to spread to and hold new areas of land, nevertheless can inflict heavy damage upon the forest communities. Shallow-rooted species like spruce or the lodgepole pine are subject to severe damage from windthrow and only by careful cuttings in such forests can heavy losses be avoided. In the Southern pine forests over which terrific tornadoes from the Gulf of Mexico sweep from time to time, the loss is quite heavy, especially if a forest of long-leaf pine has been "boxed" for turpentine (see Chapter XI), for this boxing greatly weakens the trunk. Even though the trees are not actually blown down, heavy gales may inflict considerable damage, for if the bark of a tree, which serves as a protective covering like our own skin, is broken by a torn limb, the spores of some tree disease may enter and ultimately cause the death of the tree.

The method of preventing wind damage is easy to state but often hard to secure. It consists in cutting very lightly in dangerous situations or in forests subject to windthrow. The German foresters sometimes plant

a belt or "wind mantle" of stout strong trees around a forest of shallow-rooted individuals which serves to break the force of the wind. If they find it necessary to remove trees from the interior of such a piece of woodland they remove only a few at a time in order that the others may become accustomed to the greater force of the wind and send their roots deeper into the earth to withstand the heavy buffets.

Ice and snow often injure forests by collecting upon the trunks of branches, and weighting them down until they break. Young growth of any kind or hardwoods before shedding their leaves are especially subject to damage during such storms. These injuries are practically impossible to avoid but are fortunately quite rare.

From the above description it will be seen that the life of a tree in a forest community is not free from peril. Where children in a town or city run the risk of measles or chickenpox, the little trees die in large numbers from lack of food, moisture and light. The death rate in the forest is very high in youth just as with babies in large cities. During middle age the forest appears quite healthy with only an occasional loss from lightning or from injury of some sort. As old age approaches the trees again die quite rapidly and the fungi and bacteria decompose them into humus which enriches the ground for the young forest which has started beneath the old one.

Only by close study and careful watching can the death rate of the forest be kept within bounds and the protection of the forest against harmful agencies is an important part of the forester's work.

CHAPTER IX

MEASURING THE FOREST CROP

FOREST mensuration, the measuring of the forest crop and the determination of growths and yields, is a branch of forestry which is increasing in importance with the rapid rise in timber values. When first growth timber land could be bought for a few cents or much less than one dollar per acre, the forest was "cruised" or looked over by an experienced "land looker" or "timber cruiser," who estimated the amount of timber it contained and the approximate price that ought to be paid for it by simply going through the tract. It was a matter of judgment and experience and since the estimates were always very conservative the outcome was generally satisfactory. When large corporations began acquiring extensive holdings for speculative purposes, competition became more keen, higher prices were demanded and consequently, something more than a guess was required. Thus the systematic methods of timber estimating were adopted in this country as the result of dire necessity.

In the same way the study of growth and yields was adopted. When the forest resources were considered inexhaustible a lumberman considered his forest land as a mine, to be stripped and abandoned as soon as possible. More timber land could be bought and the process repeated. Through buying virgin timber land for a song and selling the manufactured lumber at a fair figure huge fortunes were accumulated. Now that

the end of the supply of first growth timber is in sight, a different attitude is taken. Many concerns, especially paper companies with large sums invested in their manufacturing plants and costly machinery, are taking measures to derive a sustained yield of timber from their forest holdings. That is, by cutting each year no more than the forest actually grows, their supply of raw material will be continuous. The German forests have long been cut upon this principle and as a result of their careful methods the annual yield of saw timber has vastly increased during the past fifty years. Studies of this kind require scientific methods, so trained foresters are largely replacing the old timber cruiser, whose experience and judgment were his stock in trade.

"Cruising" the Forest.—Let it not be thought that the young fledgling forester can beat the cruiser at his own game, for he cannot. A lifetime spent in the forest has trained the faculties of the old "land looker" until his judgment and intuition are uncanny. He can find his way without a compass through the thickest forest. He can trace old boundary lines and discover old corners where the young forester sees nothing. He can pace distances with exactness, estimate heights and diameters with the greatest accuracy and when it comes to allowing for hidden defects in a tree, the college-trained man is a tyro beside him. Such an eye and such judgment will come only after years of experience and upon his own ground his practical experience is far superior to theoretical training. However, take the cruiser outside his own region and his experience is useless; conditions are different, the trees are shorter or more tapering and his judgment is at fault. Here is where the use of a system comes into play, for a well-trained forester can

adapt his cruising methods to different regions and with care attain results that are quite accurate. His methods, however, require a small party of men and are likely to be slower and more expensive than the cruiser who generally works single-handed or with one man. Between the two systems that of the trained forester is more desirable; his efforts produce results in the form of timber and topographic maps upon which are shown the kinds of timber, past cuttings, best logging values, etc., while the average cruiser's estimate is likely to be a lump estimate. If a practical woodsman can be taught systematic methods and to put his reports in written form the ideal estimator may be obtained.

Estimating Methods.—The roughest way of estimating timber is what is known as the ocular method and millions of dollars' worth of timber have been bought upon such reports. By simply walking across a forty acre subdivision a woodsman with good judgment can make a good guess as to how much it contains. He may do this unconsciously but in reality he is comparing the tract with others which he has seen cut down and whose yield he has known.

Some practical cruisers have devised a scheme of counting the trees on a strip of given width and by knowing the contents of the average tree, the total contents can be computed.

The method of measuring the forest crop used by the technically trained forester is based upon the plan of measuring all the trees upon a certain fraction of the forest, say one-tenth, and after computing the timber contents of this strip the yield of the entire forest can be obtained by simply multiplying this result by ten. It is an approximation of course, for only by measuring the diameter and height of every tree could the exact

number of board feet be obtained and total measurements are rarely taken.

Locating the Boundaries.—Such a system requires a knowledge of the exact area in acres so if a map has not already been made, the boundary lines must be run and the area computed. These lines are generally run with a surveyor's compass, since a transit requires too much clearing out of the line of sight to be easily used in forest surveying.

If the boundary lines have not been run for many years, their retracing is a matter of great skill and one that requires much experience. The ax marks or blazes on the line trees have grown over; the corner trees with their markings may have been blown down or burned, and it is only by exercising all the skill of a trained woodsman that many old lines can be located. For work of this sort, the aid of an expert should be secured, as he is accustomed to detecting the signs upon trees. If the lines have been run more than once it may be necessary to chop into the tree and see if the overgrown scar was made the correct number of years ago. If the correct survey was made in 1845 and the lines are rerun in 1915, chopping down to the original scars should expose seventy rings. In this way the age of the survey is told.

Strip Surveys.—After the boundaries have been located and well marked and the area has been computed, a start is made at a convenient point and parallel compass lines are run back and forth across the tract equal distances apart and all the trees on a strip four rods wide, two rods on each side of the compass line, are measured. The diameter of the trees within this strip, whose width is largely obtained by the eye, are measured four and one-half feet from the ground with a pair of large cali-

pers. From time to time the heights of trees of different diameters are measured by an instrument called a "hypsometer" and with the diameters and average heights known the contents of each strip may be obtained by consulting a table of average contents called a "volume table." Since there are ten square chains to an acre and the strip is one chain (sixty-six feet) wide, every ten chains advance means that one acre has been measured.

Ordinarily the making of a valuation survey of this kind takes a party of four men. The compass man runs the course, keeps track of the distance, either by counting his paces or by means of a surveyor's chain dragging from his belt. He makes note of the character and condition of the timber and makes a map of the country indicating the slopes, benches, mountaintops, as well as lakes, rivers, roads or any other features bearing on the logging of the tract.

The two caliper men measure the trees with calipers or a Biltmore stick. By practice they know about how far to measure out from the chain or compass lines; if they are not experienced it may be necessary for them to pace in from time to time, for a large error in the width of the strip would mean an error in the estimate. Such errors as they do make generally average up pretty well. Now they may get a tree which is too far out but in a few minutes they miss one that is within the two-rod strip each man is supposed to measure. With care, the day's work will turn out quite well. The fourth member of the crew is called the tally man. He carries a note book in which he puts a dot for each tree of a given species and diameter. He generally walks along behind the compass man and between the caliper man and checks the measurement of the trees. The

tally man generally has charge of the party and from his position can oversee the work of the other men.

These strips should always be run up and down hill for the reason that a better average of the timber may be obtained in this way. The tallest forest trees and best stands of timber are always found in the valley bottoms where the soil is deep and the wash from the hillsides provides plenty of moisture. Upon the mountaintops where the soil is thin and dry the trees are short, scrubby and far apart; hence to get a fair average of the timber in a valley a strip from one mountaintop down the slope to the bottom and up the other side must be run.

The distance that may be covered in a day depends largely on how close the trees stand and how hilly the country is. In dense forest like the spruce forests of Maine two and one-half miles or twenty acres actually measured, is a good day's work. If it has been decided to caliper one acre in ten, two hundred acres have been accounted for. In gently rolling country where the trees are far apart from five to six miles of line may be run in a day.

Sample Plot Method.—In some cases it may be more convenient to measure sample acres than an average strip. Then the contents of the entire forest is computed in practically the same way by laying off a number of one-half or one-quarter acre plots and getting the diameters of all the trees upon it. If one-twentieth of the forest is included in these sample plots, the sum of their volumes multiplied by twenty will give the total stand of timber. However, the total area of the forest property must be known.

Forestry students often obtain summer jobs in valuation survey parties, because this mechanical method

of actually measuring a certain portion of the trees requires no large amount of woods experience. Hence if the young students know their trees, they can be used to advantage in a party under an experienced compass man and forester.

Life in one of those camps is strenuous and the boys come out in the autumn trained and toughened by their work with tall stories about the mountains they climbed and the game and wonderful forests they have seen. There is a peculiar charm about work of any kind in the woods and the remarkable part of the effect of the forest is that it is largely unconscious. Before a student of forestry can be considered a real forester, he must acquire the ability to judge distance and diameters, and be able to travel the forest by day or night, to make a good camp and to cook, and above all the powers of observation must be cultivated, and the best place to acquire these characteristics is in the woods. The remarkable thing about a summer in the woods is that happy-go-lucky youngsters go in and tanned, sturdy, self-reliant young men come out. Daily contact with the primeval forest has endowed them with the sturdy qualities which it possesses. Up at daylight and out on the line for nine hours a day and a four-to-five-mile hike back to the main camp. This is the daily routine that puts muscle on young frames, toughens the mental fiber, and develops endurance. Perhaps the day's work is finished too far away to return, then a "pup tent" and blankets and grub are carried and the day's work is done with pack on back. Out in the forest at night with the wind blowing softly through the trees and the fresh moist air laden with the woodsy odors—those are the nights to be long remembered.

Every forester or boy who goes in the woods should learn how to estimate the sizes of trees. The diameter breast high is easily obtained by measuring the circumference with a string or tape and dividing this circumference in inches by three and one-seventh. The diameter is always measured breast high, i. e., four and one-half feet from the ground.

Estimating Tree Heights.—When it comes to height, either total height or merchantable height may be meant. The latter is the length of the tree that would go into saw logs. In the case of soft woods, like pines, spruce, and hemlock, the total height is generally obtained, while with hardwoods, like oak, maple, tulip, and poplar, the merchantable height is more useful. In each case the method of obtaining the height is the same. The forester gets the height of a tree by using an instrument called a hypsometer. He sets a scale to one hundred feet, paces off this distance from the tree, takes his readings and gets the height of his tree in feet. However, there are several good ways of estimating the height of a tree without the use of an instrument. A pole say ten feet long can be leaned against the tree and the number of pole lengths to the top of the tree can be counted.

One of the simplest methods is to cut a straight stick about three feet long. Held in the right fist, the grip is shifted until with the arm stretched out horizontally the tip just touches the eyebrow when the wrist is bent. Then when the arm is extended with the stick upright, a triangle is formed having two sides equal, the eye to the fist and the fist to the tip. Selecting a side of the tree to be measured where both top and base can be seen the holder backs off until, with the head stationary, the base of the tree can be seen over the

edge of the fist holding the stick, and the top of the tree over the tip of the stick. Pace the distance from that spot to the foot of the tree and the distance in feet is equal to the height of the tree. It is the old problem of similar triangles.

Getting the Contents of a Tree.—The contents of a tree are generally expressed in terms of cubic feet (a cube one foot on each side) or board feet (a board one foot square and one inch thick), while fuel or excelsior wood are commonly sold by the cord (a pile four feet wide, four feet high and eight feet long).

The board foot is the most common unit in this country and while not entirely scientific it is convenient because it gives an idea of the amount of sawn lumber that may be obtained from a given pile of logs.

On a logging job, the amount of timber in a skidway full of logs is obtained by scaling. The "scale stick," a straight piece of hickory tipped with metal and marked with figures, showing contents of logs of different lengths and diameters, is applied to the small end of the log inside the bark. If the log is ten inches in diameter and sixteen feet long the contents are read from the scale stick. Each log is scaled in this way and the contents entered in a tally book. There are a variety of scale sticks in use in different parts of the country based on the different log rules. A log rule, by the way, shows the contents of logs of different diameters and lengths while a volume table shows the contents of trees of different diameters and heights. There are over forty log rules in use in the United States. The Doyle, Scribner, Maine, International, and Spaulding are among the most important.

In case it is desired to find out how much timber there

is in a *given log* the board foot contents may be obtained as follows (the formula for the Doyle log rule):

1. Deduct 4 inches from the diameter at the small end (for loss in slabbing the log when sawed).
2. Square ¼ the remainder.
3. Multiply by the length of the log in feet.

A good method for obtaining the contents of a *standing tree* in board feet is as follows:

1. Estimate the amount of the tree that will make saw timber in terms of 16 foot logs (if a stick 36 feet long could be cut, it will equal 2¼ 16 foot logs; if 56 feet, 3½ logs).
2. Estimate by eye, deducting for thickness of bark, the diameter at the butt of this log and at the tip, say 20 inches inside the bark at the butt, and 10 inches inside the bark at the top.
3. Square the average of these diameters.

$$\frac{20'' + 10''}{2} = 15; \text{ 15 squared equals 225.}$$

4. Subtract 60 from this result and multiply the remainder by $\frac{8}{10}$ to get the average contents of a 16 foot log.

(225-60) times $\frac{8}{10}$ equals 132 board feet in average 16 foot log.

5. Multiply by number of 16 foot logs in merchantable part of tree, 2¼ or 3½ as the case may be, to get contents of the entire tree. This sounds complicated but expressed as a formula it reads:

[(Average diameter^2—60)] $\times$ .8 = contents of average 16 foot log.

It is a rough and ready rule of thumb that every forester or boy going into the woods should remember.

The science of forest mensuration is a big subject,

one upon which whole books have been written, so nothing more than a very brief discussion has been given. The simple points mentioned in this chapter should give an insight into the more important methods of measuring the forest crop, and the methods of scaling timber, cruising, etc., should make stories of the logging camp and the forest much more enjoyable.

CHAPTER X

HARVESTING THE FOREST CROP

THINK of a tree three hundred and fifty feet tall, thirty-five feet in diameter, containing 1,000,000 board feet of lumber, enough to make three hundred dwelling houses. Think of a tree that was a straight young sapling long before Athens was a power in the Ægean Sea, and was a strong giant in the prime of life when Rome fell. In fact the oldest of these forest monarchs have watched the seasons change during a lifetime of thirty-five centuries. The eucalyptus, a native of Australia, can exceed the giant sequoia in height, but there is no tree which can compare with it in bulk, age or grandeur. This is only one of many startling facts about the American forest. Regarding the extent and content of the original forest, mention has been made previously, but of the richness, the complexity, the beauty of the virgin forest of America too much cannot be said. John Muir in one of his wonderful eulogies of the American wilderness describes how the soil was lately turned by the plows of God; how the vast glaciers that ground their way down from the North, leveling mountains and filling up valleys, mixed the soils in order that the tree, the most highly developed form of the vegetable kingdom, might have the proper seedbed upon which these splendid forests could be matured. In describing the original forests the superlative must be often used, for it is true that in the woods of North America we have the largest, oldest forest trees the world possesses. We have the greatest variety as well.

Owing to the fact that the mountain chains in North America run north and south, many tree species escaped extinction during the glacial period when the northern portion of the United States was covered with a sheet of ice.

In Europe, where there are but one hundred tree species against the five hundred upon this continent, the mountain barriers run east and west, and so when the tree communities were blotted out by the enormous ice sheets, certain species were not able to surmount the mountain ranges and thus regain the ground they formerly occupied.

Forest Regions.—The study of the original forests of this continent is most interesting, and from forest remains found in rocks far beneath the surface, it is known that certain species now quite limited in their range once were distributed over a wide stretch of country. The redwood now occupying a thin belt along the coast range of California was once found far in toward the Rocky Mountains and also flourished in Europe and Western Asia.

The Pacific Northwest then, as now, was covered with dense forests in which hemlock, cedar, and the firs predominated, massive timber above and dense undergrowth, holding the world's record for uniform density. Passing to the east, the Rocky Mountain forest, containing lodgepole and yellow pine, or Douglas and white fir, or Englemann spruce, depending upon latitude or elevation, soon gives way to the treeless plains. Here mile after mile of open grassy plains are found and the early emigrant bound for California stopped his prairie schooner and made camp along the water courses, since there only could firewood be secured from the cottonwoods, box elders and willows. Still farther

Felling the Forest Giants

It took Mother Nature centuries to produce trees of this size. Future generations will rarely see specimens like these, as it costs too much to grow them.

east is found the fringe forest composed of oak, cottonwood, elm, sycamore, basswood, etc., which gradually merges into the regular hardwood forest, composed of hickory, ash, black walnut, etc., of the territory which is now Ohio, Indiana and Kentucky.

The spruce and pine forests of Maine and northern New York and the hard pine forests of the Southern coastal plains complete the list of forest regions, differing in density and kind but all valuable.

So much for the kinds of timber that awaited the ax; a storehouse containing, it is estimated, 5,200,000,000,000 board feet, exceeding in amount any like area upon any part of this globe. Since the first sawmill was erected in Virginia in 1608 more than half (2,700,000,000,000 board feet) of the original supply has been consumed by fire and commerce combined.

Early Lumbering.—The first sawmills erected in this country were exceedingly crude; water furnished the power and the daily output was from 1000 to 3000 board feet a day. The development of the sawmill by the American lumberman to its present perfection, with a daily maximum output of from 750,000 to 1,000,000 board feet, is a triumph of Yankee ingenuity. The history of the lumber industry is a story of a struggle against big odds and one containing much romance and many soul-stirring episodes. At first only the best logs were taken by the Colonial lumberman. The pine trees of New England furnished many a mast for the sailing ships of the world, and those that were stamped with the broad arrow were reserved for the English Navy. Maine was the center of the lumber industry of the New World for a long time and the "pumpkin" pine was the great

tree of commerce. Pine deals and square hewn timbers were shipped to all parts of the world, but so plentiful was the supply that only the best trees were cut, and the forest cover was scarcely broken. After the war with England the center of the lumber trade shifted westward to New York and the same process was repeated.

First the largest pines were cut, then the remainder of the pine, then hemlock, primarily for tan bark, next the spruce and finally the hardwoods, beech, birch, and maple. There are tracts of forest land in Maine that are now being cut over for the fourth time, and sad to relate, each crop is getting smaller and smaller owing to the larger amount removed at successive cuttings. Where formerly trees smaller than ten inches diameter were left on the ground they are now using them down to six inches in size.

The lumber industry in this country has grown with leaps and bounds during the past sixty years and at present ranks third in the list, being surpassed by agriculture and the iron industry. An idea may be gained of the vastness of the lumber industry and all phases of manufacture when it is realized that more than one billion dollars are invested in timber, mills, and factories, 784,000 men are employed and the annual output of mills and factories amounts to $1,156,000,000. Figures are at best dry reading and the real heart of lumbering is located in the woods where the raw material is obtained. Owing to the size of this country and the wide range of conditions, different mehods of lumbering are used so only the most important will be described in detail.

Harvesting the Forest Crop.—The oldest type of logging in the country is the spruce and pine operation of

the North Woods, including Maine, New Hampshire and northern New York. The ordinary routine of such a job is as follows:

The summer before the cutting is to begin a camp site is selected and a camp is built near the center of the piece of timber that is to be cut the first season. Log houses are usually made with shake or tar paper roofs and the crevices between the logs well chinked with mud or plaster. The camp consists of several buildings and varies in size with the operation and number of men to be housed. The bunk house, generally large enough to "sleep" fifty or sixty men; the cook house and mess hall combined, stable, blacksmith shanty, and perhaps an extra little cabin for the boss and the timekeeper, which may also serve as a company store where tobacco, socks, shoe packs, etc., may be bought, comprise the average camp. In some parts of the country portable houses are used which may be picked up and carried to the next camp site after all the nearby trees have been cut down. These are found chiefly on railroad jobs, while on the horse logging job in the North Woods the log cabin is still quite common.

While the structures for housing the men and sheltering the horses are being erected, the main haul and skid roads are being constructed. Logging in a hilly country of course requires great care in laying out the road system, and the skill which has been developed by some of the older logging bosses is of a very high order. In fact by eye alone they often lay out an entire system of log roads since their long experience enables them to choose the low grades necessary for economical logging.

When the camps have been completed and everything

is ready for the crew, the men are brought in and the actual cutting of the timber commences. A tree is felled by making an undercut with an ax, on the side toward which the tree is desired to fall. Then the tree is sawed down with a cross-cut saw, starting from the side opposite the notch. Low stumps are the rule in modern lumbering, because there is a saying among woodsmen that a foot in the stump is worth four in the top, meaning that on account of the larger diameter at the lower end, more lumber can be sawn from the butt end than from the tip. So accurate are some of the expert choppers that it is possible for them to drop a tree within a few feet of where it is desired and to watch a French Canadian flake out huge chips of fragrant spruce wood with no apparent effort, is a study in efficiency.

After the tree has been felled, the limbs are then cut off, which is called "swamping," and the log "bucked" or sawed into appropriate log lengths. The logs are then skidded, which means transporting them to the haul road, where they will be picked up by a sled or wagon and hauled out over the main haul. Skidding is ordinarily done with horses having a pair of tongs or a chain attached to the traces. The chain is hitched to the log and then it is dragged to the edge of the skid road. When the logs accumulate they are piled along the roadside to await actual hauling out in the winter season.

After the first real snowstorm the hauling commences, and upon the amount of snowfall to a large degree depends the success of many a logging job. Not only does snow make a splendid surface upon which a good team of horses can pull a large load of logs, but the snow serves to smooth out any hollows

and rough spots in the roadbed and consequently makes hauling much easier. After the road has been packed and a few sleds or the rutter have grooved the tracks, it is customary in many camps to send the tank sprinkler out over the road. This tank sled is like a city watering cart on runners and sprinkles each sled track with water. By morning each groove has frozen to make a solid track of ice. Such a splendid surface is made in this way that, if care has been taken in laying out the road with the proper grade, a team of horses can pull any load of logs which they are able to start.

It is always the aim to have the outhaul road descend gradually, which means that gravity helps the horses. In steep country, however, sharp pitches are common, and navigating these steep slopes is the dangerous part of the driver's work. The speed of the loaded sled may be checked by spreading hay or evergreen branches across the road, or in some cases removing the snow entirely. In spite of all precautions loaded teams often run wild and many a pair of horses and driver have been piled up under a load of logs at the foot of such a slope.

In some parts of the spruce country, railroad logging is now being used. The sleds carry loads of logs to the loading skidways placed on railroad spurs. The logs may be either rolled upon the cars by gravity or a steam loader may be used to lift the logs from the ground and place them upon the cars. When the cars have been loaded, the train starts for the mill.

Life in a Lumber Camp.—The life of the average lumberjack, while containing considerable romance and excitement, is nevertheless one of hard work under conditions that are frequently rigorous. In many

logging camps the sleds are loaded in the morning by lantern light, and the work continues so far into the twilight that teamsters and choppers working at a distance return to the bunk house after dark. The men are well fed with wholesome food, which disappears with astonishing rapidity. For sixty hungry men working for twelve hours in a zero temperature swinging an ax, pulling a saw or using a cant-hook will make short work of the evening meal. Baked beans, always a staple dish in a logging camp, are cooked in huge wash-boilers, and doughnuts or fried cakes are generally turned out by the tubful. However, in spite of the hard work, there is much that is amusing and many jokes are played. In the past, the lumberjacks of New England and New York were largely recruited from the ranks of the French Canadians, and their songs and pranks added much to the color and life of the camp. A newcomer ordinarily has a hard time until he is initiated, for all sorts of tricks will be played upon him. His clothes and bedding may mysteriously disappear, only to be found in the top of a high tree near camp, and when he climbs the tree to collect his belongings, two of the best choppers in camp will station themselves at the foot of the tree and chop it down before he can descend. The unlucky novice clinging to the limbs comes down with a crash, and may disappear entirely in a deep snow drift. The life is rough, the men are goodhearted but reckless, and unfortunately some of their jokes may have disastrous results.

After a hearty supper at the end of the day, the men collect in the bunk house for their evening recreation. Songs are sung and yarns are told about the fearsome animals of the woods and legends of the

phantom canoe, and many other tales are told common to the north country. After an hour or so of yarn spinning and an evening pipe, the crowd turns in to a dreamless sleep upon their balsam beds.

"Driving" the River.—Throughout a large part of the spruce country, lakes and rivers are found which make transportation of any timber that floats comparatively easy. Spruce and pine in any condition and poplar and hemlock after barking will float, hence these species are capable of water transportation. During the hauling season while the snow is on the ground, the logs are hauled to the edge of streams or piled upon the ice of the lake; when the ice melts in the spring the logs sink into the water, or if upon the river bank are rolled in, each log, however, being first measured and stamped with a distinguishing mark. The logs then float upon the spring freshets down through the brook, past the rapids on their way to the sorting boom at the mill.

The most skillful rivermen are selected from the entire logging crew, and upon these men in charge of the driving boss falls the duty of getting the winter's cut to the mill town far down the river. Driving the river is hard work under high pressure, as the water may subside any day and consequently long hours of labor are the rule. A crew of river drivers equipped for the job, attired in rough clothes, their trousers "stagged," or cut off below the knee, feet encased in heavy woolen socks, stuck into boots, the soles of which are spiked or "calked," make a picturesque and striking sight. Their duty is to keep the logs forever on the move. When the current carries the logs ashore, with cant-hook and pike-pole they will force them back into the stream again, and time and again will rush

across the stream, leaping from log to log which may partially sink under their weight. Their skill in balancing upon these floating logs is marvelous, and to see two expert river drivers "birling" is a sight never to be forgotten.[1]

In swift water the logs travel rapidly and unless there are bowlders or other obstructions in the river the chief duty is to pry the logs from the shore and push them out into the swift running water in the center of the stream. When, however, an obstruction is met, trouble is in store for the entire driving crew. One heavy log may catch upon a rock or sandbar, a few more immediately behind it pile into it and a "jam" is formed—a pile of logs pointing in every direction like jackstraws. The size of this jam increases every minute as the swollen stream brings down logs continuously. Soon the pile actually fills the stream and in some cases the water may be backed up by the obstructing logs. Now is the time to rush out on the pile and pull away furiously at the front of the jam, log by log, working like beavers, with cant-hook and pike-pole, until the unruly member, the "key log" is found. When this is removed the jam starts slowly at first but rapidly increases in speed, while the expert drivers who have broken the jam rush madly to safety, peavy in hand, jumping from one bobbing log to another amid the encouraging shouts of the less experienced rivermen who have been watching them from the shore. In extreme cases it may be necessary to start the jam by means of dynamite.

[1] Birling—rotating a floating log by treading it. When two experts indulge in a birling match the best balancer wins; a sudden stop of the spinning log throws the unwary or slow moving driver into the river.

Courtesy U. S. Forest Service

THE END OF THE DRIVE

The winter's cut of logs held in a big boom ready for sorting and delivering to the various mills.

This was the life of the drive, but the day of the "white water boys" is passing with the increasing use of railroads in lumbering. Hard work, long hours of toil, clothes continually soaked, with a big celebration in the mill town to mark the end of the drive—this was the life of the typical river driver. Tricks may be played upon the "drive," as well as in the camp, and woe betide the "jumper" for he will more than likely wear soaked clothes most of the time.[1]

When the logs have reached their destination, their course is checked by a huge boom, or string of logs stretched across the river. From the sorting boom, the logs are allowed to escape one at a time, and they are grouped according to the marks which they bear. All of the logs containing the same mark are stored in the same boom or pocket to await the need of the mill for which they are intended.

Cypress Logging.—In the cypress swamps of the South a different kind of logging is practiced. Cypress, for the most part, grows upon land which is submerged for a large portion of the year. This ground makes poor footing and hence horses or oxen can rarely be used, as the ground is too soft. Consequently a type of logging known as the "pull-boat system" has been devised. Canals are cut through the swamp at strategic points. A pull-boat, a large flat-bottom scow, equipped with a huge engine and drum for winding up a long steel cable, is towed to the point where logging is to commence. The

[1] A "jumper," a nervous fellow who jumps or obeys any sharp command shouted unexpectedly in his ear. A story is told of a jumping French Canadian who was proudly carrying his baby home from the christening. One of his friends, knowing Baptiste's failing, stole up behind him, slapped him sharply on the back and shouted in his ear, "Throw it!" Without an instant's hesitation he threw the baby into the snowbank.

cypress trees have been girdled a few months previous in order to dry them out somewhat and increase their floating capacity. When the trees have been felled the cable of the pull-boat is hauled out into the woods, the logs are attached to the end, the engine winds up the cable upon the drum and the logs come crashing through the swamp until the canal is reached. In the canal the logs are joined together and towed to the mill.

Lumbering on the Pacific Coast.—In the Pacific Coast region still another type of logging has been devised. On account of the huge size of the trees and logs found there, the loads are too large for horses or oxen to be used advantageously. Consequently the resourceful lumberman has made use of stationary steam engines of mammoth size to bring in the enormous trees. The trees are felled and in some cases exceedingly high stumps are cut, a spring-board being used upon which the choppers stand while felling the trees. Extreme care must be used in felling these forest giants, as, on account of their size and the force with which they fall, a trunk may be badly broken when it hits the ground. The undercut is very carefully placed so that the tree will fall upon a good landing and in some cases a bed may be prepared to break the fall of the huge trunks. After the tree has been felled the logs are "bucked up" as usual, and bunched by means of a yarding engine, a huge stationary engine equipped with a revolving drum and cable. The logs are assembled in a yard and at this point may be loaded on cars for transportation or if the mill is near by a train of logs may be made and another huge engine located at the mill will pull in this string of logs in a groove or chute. If the logs are of moderate size, in some cases cables may be strung

from tree to tree and the logs are carried suspended from a wheel which travels upon this cable.

Sawing the Logs.—When the logs finally reach the mill they are stored in a millpond if water is available, for water storage is desirable with practically every species which floats. These millponds may be from two to three acres in extent and will hold a large number of logs. From the storage pond they are hauled up an inclined plane by means of an endless chain equipped with teeth called the "bull chain." When the log reaches the top of the plane it is rolled from the trough in which the chain runs to the deck, a sloping floor pitched toward the track upon which the saw carriage runs.

A marvelous place is the interior of a sawmill, one that stimulates so many senses that the effect, to say nothing of the noise, is bewildering. As previously stated the modern sawmill is the pride of the American lumberman, and its skillful arrangement is a tribute to his ingenuity. From the door in which the log enters from the outside its course proceeds in a straight line until it reaches the grading table ready to be graded, sorted, and stacked. The light inside is rather dim but after a minute or two we can make out the arrangement of the mill and understand the various operations.

As the log pokes its end into the door from the millpond a man with a slim hickory stick upon which figures are burned rushes forward to measure the log at the small end. He is the scaler and after measuring the diameter of the log he reads its contents in board feet from the hickory stick (log rule or scale stick) having estimated the length by eye. This he records in a book, as the owner wishes to know how much timber has been cut in the woods and how much the sawyers should saw out.

From the trough the logs are shunted out upon the sloping deck from which they are rolled upon the saw carriage, which slides back upon its track to receive a new log when the last board has been sawed from the previous one. Ordinarily two men ride up on the carriage, and it is their duty to fasten the log in position and push it forward enough to cut the thickness of board desired by the sawyer. Back and forth upon the track rushes the saw carriage, hurling the log upon the rapidly revolving band or circular saw. The sawyer stands near the saw with the levers controlling the machinery within easy reach. At his direction the "setters" on the carriage push the log forward to make a one- or two-inch board, according to the possibilities of the log; upon his skill and judgment may depend the profit of the mill, as a poor sawyer may ruin many thousand feet of lumber each day.

After the whirling saw has sliced a slab from the log the carriage rolls back to the end of its track and rushes again toward the saw. The boards which are cut from the log are carried forward on revolving rollers, called "live rolls," and passed through the "edger," which removes the bark and leaves the board with straight edges. The slabs and edgings are disposed of by being cut into short pieces and carried out to the refuse pile where they are burned. In the meantime the boards are trimmed to the proper length, fourteen, sixteen or eighteen feet as the case may be and finally they reach the grading table, a long platform upon which they are kept moving by an endless chain. Here an expert inspects each piece and marks it with an appropriate sign which indicates the quality and the pile in which it belongs.

Seasoning the Lumber.—The only process remaining

is that of seasoning, which may be done by piling in the open air for several months and permitting the moisture to evaporate gradually, or as in most modern mills the moisture may be removed by stacking in an oven, and heating to a high temperature for a short time. The latter way is much quicker, and saves much time in waiting for the timber to dry. When seasoning has been completed the lumber is then sorted and piled, awaiting shipment, and is ready to be made into houses, furniture or put to any of the countless uses which make the products of our forests so necessary to our civilization.

CHAPTER XI

THE MOST INTERESTING FOREST PRODUCTS

PERHAPS the story of the forest as told thus far has appeared tedious and the tale of how tall trees are turned into lumber has become tiresome. However, there are other products of the forest, the story of whose manufacture will be of great interest, for the forest furnishes many other things for our use which have not yet been mentioned.

Maple Syrup and Maple Sugar.—Perhaps the most interesting forest product to the average young person or even grown-up with a sweet tooth, is maple syrup which is made by boiling down the sap of the hard or sugar maple until the sweet syrupy liquid is obtained. Maple sugar is made by the same process, but the sap is boiled a longer time until the sugar crystallizes. The manufacture of maple syrup and sugar is quite an important industry in the States where the sugar maple is common and the "sugar bush," as the grove of maples which furnishes the sweet sap is called, is a busy place during early spring. At present Vermont, New Hampshire and northern New York furnish large quantities of sugar products, and may be considered the centers of production in this country.

The management of a sugar bush is quite different from that applied to an ordinary woodlot. Where timber is desired, the crowns are kept small and the growth of tall trunks is encouraged. Where large quantities of sap are desired large spreading crowns are allowed to

develop and little attention is paid to the form of the tree trunk. Upland trees on good rich soil produce the best sugar for while trees growing on moist sites may produce plenty of sap, not so much sugar is obtained from it when it is boiled down.

When spring comes in earnest and warm thawing days are followed by cool freezing nights is the time for great activity in the sugar bush, for such climatic conditions make the sap run freely. The run of sap is easily disturbed and it is claimed that a southwest wind or approaching storm may cause the flow practically to cease.

Holes are bored in the tree about two inches deep and a wooden or metal spout is inserted. Outside of discoloration little harm is done as the soundness of the trunk is rarely affected and it is not an uncommon incident on cutting down a sound old maple in the woodlot to find spout marks covered up by from thirty to forty rings of wood. From the spout is suspended a pail the best type of which is equipped with a cover to keep out twigs and dirt of all kinds. These buckets are emptied as fast as they fill, their contents usually being poured into a tank or barrel placed upon a "stone boat" or drag. Formerly the sap was boiled in a large kettle in the open but the modern sugar bush is equipped with a storage tank from which the sap can be drawn into the evaporating pans situated within a house. The old method was extremely picturesque for the blazing fires and the bubbling caldrons emitting fragrant steam, left an impression hard to forget but the new way is much cleaner and more efficient. Not more than two holes are bored in the average tree although extra large crowned individuals standing upon the edge of the woods may be tapped with three

Courtesy U.S. Forest Service

SPRING IN THE SUGAR BUSH

After the sap is collected it is boiled down in pans or kettles until the delicious syrup or toothsome sugar is obtained.

or four spouts. The average tree will yield from twenty-five to thirty gallons of sap in a good season, from which two quarts of syrup or four pounds of sugar will be produced.

While maple syrup and sugar are common enough throughout the northeastern States, the undiluted article is rarely found in the city store, and only those who have attended a sugaring-off party in the "bush" where maple goodies are made by pouring the boiling sap upon the snow to cool, can realize the real sugar flavor. Under such circumstances the taste excels most of the confections sold in shops.

Paper-making.—While the story of how paper is made may not have the same interest attached to it as has something good to eat, nevertheless the manufacture of paper stock for magazines and books from forest trees constitutes an interesting chapter in the story of the forest.

While paper was made from many kinds of fibrous matter by the Chinese at a very early date, the vegetable kingdom seems to have supplied the bulk of the writing material from the very beginning. In fact the word paper is derived from "papyrus," the name of a reed which grew in the delta country of Egypt. The earliest paper of which there is record is that used by the Arabs in the ninth century and some very interesting manuscripts written on paper of that period are still in existence. This paper was made of the wood of the cotton plant which was reduced to a pulp by a process discovered by the Chinese and learned from them by the Arabs.

Paper was used in England commencing about the fourteenth century but for a long time was made from rags and scraps of parchment. This rag paper made

by hand was very durable but quite expensive. With the rapid increase in the number of newspapers in order to fill the demand for an elastic free-running paper, the process of manufacturing paper from wood was invented.

Spruce on account of its long strong fiber is especially desirable as a source of wood pulp and at present supplies more than half the stock used for paper. However, more than a score of species furnish material for wrapping paper and fiberboard.

Manufacturers divide the kind of pulp made from wood into two classes—mechanical and chemical. In the manufacture of pulp by the mechanical process the wood is ground up into bits by pressing each piece of the tree trunk—they are called "bolts"—against a rapidly revolving grindstone. These wood fragments make a very coarse pulp from which fiberboard and ordinary pasteboard boxes are made. This ground wood may be mixed with chemical pulp to make newspaper stock, about three-fourths of the paper being composed of ground wood. The ease with which such paper is torn is largely due to the presence of the untreated pulp, but the discoloration of a newspaper after a short time is due to the presence of sulphur in the chemical pulp.

In the manufacture of paper by use of chemicals the wood is first chipped instead of being ground, as the fiber must be kept whole. The chips are then treated with soda or sulphurous acid which dissolves away all the impurities and leaves behind nothing but the wood fibers. This part of the manufacture—the "cooking"—is done in large upright cylinders called digestors. After the cooking is finished the pulp is washed, beaten and then diluted with water until it is very thin, in

fact, so much water is added that the solution takes on a milky hue owing to the fine wood fibers held in solution. This liquid is sprayed out upon a screen which is shaken continually from side to side and as a consequence a large part of the water falls through the mesh. As the water is shaken out the wood fibers commence to "mat" and gradually a thin sheet, very delicate at first, is formed upon the wire screen. As more water is removed the felted mass of wood fibers becomes stronger and is transferred from the wire screen to a long endless felt blanket. This blanket with the thin moist layer of paper on top is carried along beneath some heavy rollers which press the remaining water from the matted sheet of fibers. After further application of pressure and heat, still more water is lost and finally the paper is strong enough to bridge the gap from one roller to the next without any support beneath. The remaining steps consist in giving the paper a high finish by means of still heavier pressure and higher heat. Finally the sheet of paper is wound upon large rolls which contain many hundred pounds.

Outside of the most expensive bond and letter paper which is still made by hand the above description would hold true for a majority of the print and wrapping papers.

Nut Gathering.—While in this country the nut crop is rarely seriously considered, in Europe great attention is paid to this yield of the forest. The "mast," as it is called, forms an important part of the food of swine in Germany and in Italy large quantities of chestnuts are grown to be consumed as chestnut meal. Of all nuts common to the East the chestnut is in greatest demand and after the first severe frost large numbers of people,

especially foreigners, start out for the purpose of gathering chestnuts for the market and close to the city quite an industry may be built up. From the lower boughs the nuts may be beaten off with poles but the upper limbs must be shaken. After the nuts have reached the ground the leaves and débris beneath are raked away in heaps and the partially opened burrs put into a separate pile so that they may be examined. The loose chestnuts are put into bags and later sorted in order to separate the defective and wormy specimens. The chestnut gatherers as a rule sell their crop by weight, fifty-six pounds being the average bushel and the average price received is about four cents a pound or two dollars and twenty-five cents a bushel. In a good chestnut country a family of four or five persons will earn as much as ten dollars per day. It is a family job primarily because children can be useful in sorting the nuts, or extracting chestnuts from the half-open burrs.

Practically every part of the East has its favorite nut. In the Middle Atlantic States in addition to chestnuts, walnuts and hickory nuts are found while in the Southern States the pecan may be added to the above and in the Southwest, Indians collect large quantities of the edible seed of the nut pine. At the present time the nut industry in this country bids fair to increase and there are a few orchardists who make a business of raising nuts for the market or propagating pedigree trees. With large areas of inferior mountain land throughout the Atlantic States, the raising of nuts offers a splendid solution of the land problem, for such a crop needs much less labor than an orchard, and aside from furnishing food for swine or man the lumber growth is an added profit.

Naval Stores.—In early Colonial times among the

most important products for export were the so-called naval stores, the turpentine and rosin extracted from the resinous sap of the Georgia pine. At the present time this is still a business of considerable magnitude, for each year products aggregating $25,000,000 are manufactured. On account of the character of the Southern forests the manufacture of naval stores is an industry devoid of risk and romance but a story of how turpentine and rosin is made may be instructive. Practically speaking only the longleaf or Georgia pine furnishes resin of the composition from which turpentine can be made. From the sap of the Cuban and other pines, naval stores are extracted but the amount they furnish is quite small by comparison.

The steps in making turpentine are as follows: Close to the ground a deep notch pointing in toward the center is cut in the large trees. This notch, called the "box," collects the resinous exudation which oozes from the cuts on the bark above. Each week a new streak is hacked which exposes a new portion of the bark farther up the tree, thus opening fresh tubes and keeping the tree bleeding continually. A certain amount of the resin dries before it has flowed down to the box and this portion may be scraped from the tree afterward. The fluid resin which collects in the box is dipped out with a paddle and carried to the turpentine still in barrels where it is heated in a copper kettle, equipped with a long coiled pipe or worm which serves to condense the turpentine which distills over.

The most up-to-date orchards collect the resin in a Herty cup instead of the old-fashioned "box." This cup may be moved up the tree as the occasion demands and as a result more turpentine is obtained by reducing evaporation. Progressive operators are using the cup

Courtesy U. S. Forest Service

A TURPENTINE ORCHARD

The resin which oozes from the freshly chipped bark runs down the metal gutter and collects in the cup.

system for in spite of the first cost it is very economical in the long run.

Manufacture of Cooperage.—Along certain lines man's ingenuity has made it possible to substitute other materials for wood. Houses, bridges and telephone poles are being made of steel and concrete but no material has yet been found that will take the place of wood for making vessels containing valuable liquids. Wood is cheap, easily worked and desirable since the best woods impart no taste to valuable products like wines or salt meats.

No American species has had the popularity which the white oak enjoys in the cooperage industry and from the Appalachian forests large quantities of staves have been produced which were used by the wine-growers and distillers of this country. For the so-called "tight cooperage," white oak stands nearly alone although of late years cypress has replaced it to a very small extent. To be used for tight cooperage a wood must be absolutely impervious. Even red oak cannot be used for tight barrels advantageously because its open pores permit of slight leakage in contrast to white oak which is watertight.

For making lime, fruit, and flour barrels the requirements are not so strict and many kinds of lumber may be used. Elm, red oak, ash, beech and maple are all used to make staves of this kind.

While the manufacture of staves for tight cooperage is generally a business in itself, slack cooperage may be turned out as a by-product from the waste of a regular lumbering operation.

Wood Distillation.—The manufacture of alcohol and acids from wood is an industry of growing importance in this country. Already many plants have sprung up

in the Northern woods where beech, birch and maple are found. Unless care is taken, the manufacture of these materials is likely to result in forest destruction as the average plant prefers small "bolts" which are obtained from second-growth forests, cut over before the trees are full grown. However, if a distillation plant is operated in connection with a sawmill the slabs, limb and top wood, which would otherwise rot in the woods will be consumed in the distillation process. Such a combination means close utilization and serves greatly to reduce the risk from forest fires as it disposes of large quantities of tops and branches which would otherwise cover the ground for years.

The ordinary process of making wood alcohol consists in heating the bolts of wood in an oven or retort for about twenty-three hours. The valuable liquids are condensed in a worm while the charcoal remains in the cylinders. From the hardwoods, acetate of lime, wood alcohol and charcoal are obtained while the distillation of the Southern pines yields turpentine, wood acids, heavy oils and charcoal.

Veneer Industry.—Wood is not only used as sawn lumber but of late years certain species have been used in the form of thin sheets called "veneers." One of the most common uses of veneer is to cover furniture made from a cheap kind of wood with a thin sheet of beautiful figured species like oak or mahogany. This is by no means a new method, however, since many old pieces of furniture are made from solid mahogany with a more attractive sheet of the same wood placed upon the top. The present use of veneers, however, is much broader in scope.

A little more than ten years ago certain trees like the Southern red gum were considered of little or no

value on account of their cross grain and the difficulty experienced in seasoning them. Investigation proved, however, that after steaming, these logs could be sliced into thin sheets which would serve very well in the manufacture of berry crates, baskets, trunks, etc.

The use of veneer for crates, barrels and baskets is comparatively recent and has made certain species rise in value. An idea of the extent of the veneer industry may be obtained when it is realized that all together 500,000,000 board feet of lumber are annually used for this purpose in the United States.

Additional uses of forest products might be mentioned, such as the manufacture of excelsior from poplar and basswood trees, or the use of oak or tamarack for ship knees and timbers. Certain trees and shrubs furnish flavoring extracts and medicinal oils but the distillation of birch oil and witch hazel extract are industries of decidedly local importance. The fruit of the wild cherry and chokecherry is used to make wines and cordials, slippery elm bark is obtained from the tree of the same name and from a Western tree called the buckthorn the drug known as cascara is obtained.

While doubtless the increasing use of substitutes like steel and concrete will cause some reduction in the drain upon the national timber supply, nevertheless, there are certain demands which can be supplied only by the products of the forest. From the very beginning the forest has played an important part in the development of this country and from present appearanees it is likely to do so until the end of time.

CHAPTER XII

HOW WOOD IS PRESERVED

One of the greatest drawbacks to the extensive use of wood is that while it is easily worked and the first cost is comparatively slight, it may be expensive in the long run because it is subject to decay, especially when used in contact with the ground.

Reasons for Decay.—Decay in wood as in any substance is due to the action of bacteria and fungi and as a rule timbers containing considerable moisture and sugar are much more subject to disintegration. The agencies causing decay must have food, oxygen, a certain amount of heat and water in order to live and thrive, and if any one of these necessities is removed from the wood, decay can be postponed for a long time or prevented altogether. If a fence post has been thoroughly seasoned before being put into the ground it will last much longer than one which was used green, as the moisture in the freshly cut stick is favorable to the action of the bacteria and fungi. If air is cut off from timber the agencies causing decay cannot work and that is the reason the oak found in English bogs and the pile foundations of the Swiss lake dwellings are in such a splendid state of preservation.

Methods of prolonging the life of wood have long been known, for in the earliest times the Ancients succeeded in preventing decay by impregnating timber with cedar oil or coating their statues with oils or by

charring. They also realized that proper seasoning made wood more lasting and it was a common custom to submerge timbers in sea water for a long time in order to increase their durability.

It can be readily seen that increased durability of construction timber greatly reduces the cost for to the initial value must be added the expense of replacing decayed railroad ties, etc. Consequently it is true economy to adopt measures which will prolong the life of structural timber and which not only diminish the total cost but also greatly reduce the drain upon our forests by permitting inferior woods to be used in place of those having greater durability. For years the railroads of the East would use no other wood for ties except white oak but finally scarcity of this species led to the use of yellow pine, red oak and chestnut. With the decrease in the supply of these three species most of the Eastern railroads are beginning to use beech and birch and other hardwood timber for ties which, however, must be first treated with creosote before using, in order that rapid decay may be avoided. In the South large numbers of railroad ties are made from "old field pine." These ties should be impregnated before being placed in the roadbed and on account of their softness should be protected by a rail plate in order to endure.

Two general methods may be used in prolonging the life of wood. The first is seasoning, during which process a large amount of moisture is removed from the timber. The second method is chemical treatment.

Effect of Seasoning.—While it may not appear at first glance that seasoning timber is a method of preservation, nevertheless, its effect in increasing durability cannot be doubted. Fence posts and telephone poles which have been seasoned before using will show no signs of

decay above the ground level but just at the point where they enter the ground they become soaked with moisture and rapid decay takes place. Wood when used green and full of sap is extremely inviting to fungi because in addition to moisture the sap contains starches and sugars which supply the agencies of decay with plenty of food for their development. The seasoning of timber not only adds greatly to its durability but also increases its strength to a marked degree.

In some cases timber is allowed to season in the log but as a rule, seasoning in the round is due to an oversupply of logs rather than to intention. When logs have been sawed into planks greater surface is exposed to the air and consequently the seasoning process is more rapid. The change in strength and durability after seasoning is not alone due to the loss of a certain amount of water but in addition there are certain changes in the cell walls.

The seasoning of lumber is an extremely important part in its manufacture and sawmill men select the location for their mill with great care. Timber may be ruined by poor seasoning or at least the grade of the material may be lowered, thereby decreasing its value. If the mill site has been unwisely chosen so that free circulation of air is impossible, material may season very poorly and a fungus growth like "blue stain" will be extremely common with certain species which will spoil the appearance of the valuable grades. The length of time which timber is allowed to season in the pile depends much upon the species. Conifers will be well seasoned in from three to six months while hardwoods require close to a year for perfect seasoning. Manufacturers very often will ship lumber before it is wholly seasoned for by removing a part of the water

before shipment they greatly diminish the weight and the shipping charges. The balance of the seasoning takes place in the yard of the retailer.

Most of the large lumbermen at the present time are drying their product artificially as much time is saved and thus a large stock of lumber is not kept on hand. Timber is seasoned artificially by placing it in a kiln and heating to a comparatively high temperature for a short time. Heat, however, must be very carefully applied as too rapid drying will result in warping and cracking.

Certain hardwoods require skillful treatment and in order to get the best material such grades as maple flooring must be handled with especial care.

Charring Timbers.—A crude method of preventing decay in small timbers, which is partially a chemical method and partially seasoning, is often practiced with round timbers in the country, especially fence posts. This consists in charring the timbers before they are put into the ground. The application of heat serves to dry out thoroughly the exterior portion of the post, and in addition, by changing the last two or three annual rings to charcoal, a coating of material little subject to decay is put around the part that is exposed to dampness.

Chemical Preservation.—Regarding chemical methods of wood preservation practiced in this country several kinds are used, depending upon the size of the timber and the equipment available. A good many chemicals have been used at one time or another but at present the list has been greatly reduced. To get perfect preservation the substance used should be poisonous to fungi, easily soluble so as to penetrate deeply and should be quite lasting. It can be readily seen that these qualifi-

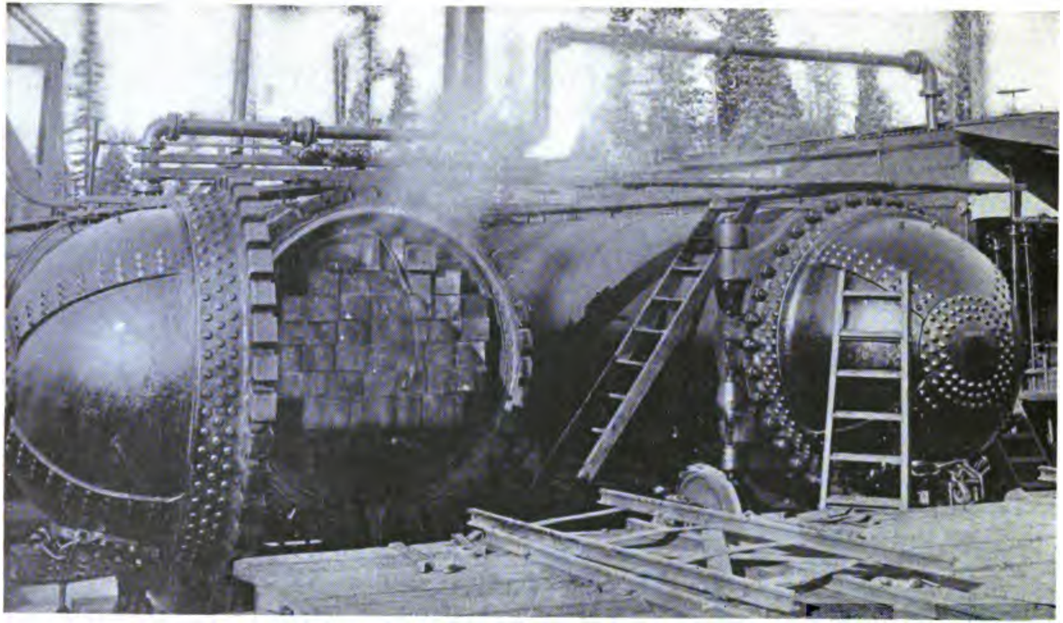
cations are hard to obtain in a single substance. At the present time zinc chloride gives good results where timbers are not subjected to continuous moisture, but in spite of its higher cost creosote is being more widely used on account of its lasting qualities.

Small round timbers or shingles may be made quite durable by an application of hot creosote or coal tar applied with a brush. This preservative kills any bacteria or fungi present in the outer layers and the antiseptic coating also renders the timber impermeable to water and air. Such a treatment is very beneficial but its effect is not lasting. Deeper penetration may be obtained by submerging small timbers to be preserved in a tank half full of hot preservative. This kind of treatment is spoken of as "open tank" preservation and is often done on a small scale by farmers. By heating creosote in a tank or open barrel to a high temperature and then putting the fence posts to be preserved in the boiling liquid and allowing them to remain until it is cool, a large amount of the preservative is absorbed and the material so treated proves very durable. Where deeper penetration is needed or the preservation of ties or timber is done on a large scale, as in the case of railroads or regular treating plants, the preservative is generally applied in a cylinder where pressure can be applied to force it deeply into the wood. When timbers are to be placed in a moist situation or where for any reason conditions will be favorable to rapid decay, complete impregnation should be obtained. This is possible only under high pressure and is a very expensive operation owing to the difficulty of the process and the amount of preservative consumed. Complete impregnation is rarely used, however, and as a rule if the outside of timber is soaked with creosote to the

depth of an inch to one and a half inches, it is considered sufficient.

Piles and paving blocks are being treated extensively at present but the preservation of railroad ties constitutes ninety per cent of this industry in the United States. Railroad ties are treated only by the pressure method. The plant needed for such an operation consists of several long cylinders from six to eight feet in diameter and about one hundred to one hundred and fifty feet long. The ties to be treated are first thoroughly seasoned so as to remove practically all available moisture, they are then loaded on cars which are run into the cylinder and the doors tightly closed. Live steam is turned into the cylinders under high pressure and after five or six hours the steam and air is pumped out and a vacuum is created which draws air and moisture from the cells of the timber. The preservative, which may be either creosote or zinc chloride, is forced into the cylinder and maintained under approximately one hundred pounds pressure until the required amount has been forced into the wood—gauges in the tank show how much has been absorbed. Ordinarily for complete impregnation twenty-five to thirty pounds of creosote is needed for each railroad tie. This makes the treatment comparatively expensive for it may run up to forty-eight cents for each piece, but ordinarily less creosote is used, as there is little extra benefit obtained from the extra material. The average cost of treating a tie is thirty-five cents, while poles and fence posts average one dollar and fifty cents and ten cents respectively.

After removal of the treated timbers from the cylinders, test holes are generally bored to learn the depth of penetration. Cut surfaces are repainted, as



Courtesy U. S. Forest Service

HIGH PRESSURE CYLINDER FILLED WITH RAILROAD TIES

Where formerly only durable woods could be used for railroad ties, impregnation with chemicals causes inferior woods to serve fully as well.

any place where the impregnation has been slight may be attacked later with agencies of decay.

The toredo, a boring mollusk found in tropical waters, has been found to attack creosoted piles only where blows of a sledge had dented the wood and diminished the thickness of the treated layer.

If care is used in controlling the temperature and strength of the solution used, treated timbers will be fully as strong as they were previously. Under new methods, especially those in which creosote is used, there is no chemical reaction between the wood fibers and the preservative; the creosote simply forms a film around the fiber. The amount of heat used in this process can be carefully regulated but the amount of moisture contained in the treated timber is of much more importance. Creosote retards both the evaporation and the taking up of water and therefore, if thoroughly seasoned wood is treated, it will be practically impossible to take up any water afterward. But if the wood is not thoroughly seasoned before treatment rapid disintegration may take place. This is quite similar to the dry rot that is found shortly after partially seasoned or green wood has been painted.

Treatment with zinc chloride may produce unsatisfactory results, especially if the timbers are not thoroughly dried before being used. However, there seems to be a chemical reaction in this case, for if too strong a solution is used, the wood fibers are corroded and a noticeable loss of strength occurs.

The chemical treatment of wood to prevent decay is long past the experimental stage in this country and it is a practice certain to increase. In view of the fact that decay alone is responsible for seventy per cent of all the destruction of timber, economy demands that

this loss should be decreased. The rapid increase in price due to diminishing supply of the naturally durable woods has forced the consumer of construction timbers to substitute cheaper and less lasting species and this fact alone will inevitably result in increased preservative treatment.

Costs and Effects of Preservation.—When it is realized that at a cost of thirty-five cents for impregnation a railroad tie costing seventy cents will last seventeen years instead of seven, the economy of this practice can be seen and the wisdom of the American wood consumer in reducing the drain upon the nation's forests by the use of preservatives can be highly commended. That timber preservation is on a rapid increase is evident when it is realized that during the past nineteen years the number of plants for the treating of timber increased from fifteen to one hundred and twenty-two. Of the present number one hundred are of the pressure cylinder variety.

During the past year nearly 80,000,000 gallons of creosote, 27,000,000 pounds of zinc chloride and 2,500,000 gallons of other preservatives such as crude oil and coal tar were used. Altogether 160,000,000 cubic feet of timber was preserved which in the form of railroad ties would be sufficient for a new line 1100 miles long. The rapid rise of the preservation industry is a striking example of the increasing economy which is being practiced regarding the products of the forest.

CHAPTER XIII

CITY FORESTRY AND SHADE TREES

FROM earliest times the beauty of trees has been recognized and so great has been their charm that in some countries they have been made objects of worship. In Grecian mythology the wood nymphs and dryads played an important part while the oak worship of the Britons under the leadership of the Druid priests is an interesting fact concerning the religion of the early inhabitants of the British Isles. In such great esteem were these venerable oaks held that prisoners were often sacrificed to them during the religious ceremonies.

The practical uses of trees, how they serve to shelter man, provide him books and furniture; how they are necessary to the huge transportation systems which distribute the foodstuff of the world have already been discussed. Trees serve still another purpose, since by their beauty and shade they make the villages, towns and cities of our country more attractive and livable for it is hard to estimate how much trees add to the charm and the permanent well being of the city dweller. As a result of this need of trees in the larger towns and cities there has arisen the profession of "city forester" or arborist, a man who tends the trees grown for the purpose of beautifying streets and parks, rather than for timber purposes.

During the time this country was being settled little thought was given to comfort or beauty. In New Eng-

land, villages were built on the hilltops to be safe from attack by the Indians in spite of the fact that the poorest farm land was to be found on these dry thin-soiled ridges. With the arrival of less strenuous times and general national prosperity, some thought can be given to the appearance of our cities and it is coming to be realized that beauty is an advantage worth possessing. In the past trees have been sacrificed for utility; if a sidewalk needed repair the roots of all the nearby trees were hacked off without considering whether or not the trees would die; if a telephone line was to be strung the branches were cut to suit the needs of the wires and rarely was the height of the poles arranged to save a row of shade trees. Fortunately this era of our civilization is now passing. The appearance of the cities is being studied. Most of the large cities have park boards, shade tree commissions, city planning committees, etc., and all such organizations recognize the importance of trees in developing a beautiful city. Whether singly or in groups there is nothing which relieves the bleakness and adds to the charm of streets like well chosen lines of trees. Bacon in one of his essays says that when a nation becomes prosperous the first evidence is that splendid buildings are erected while later on they commence to "garden finely as though gardening were the greater art." This observation seems equally true regarding shade tree and park improvement, for schemes for paving streets and for erecting municipal buildings usually precede park and shade tree work by some years.

Value of Shade Trees.—The need of trees in our cities is more than an attempt to satisfy the love of the beautiful, for by sheltering the paved streets from the intense heat of the sun and by evaporating large

quantities of water from the surface of the earth, the presence of large numbers of trees in a city has an appreciable effect during the heated term. The New York County Medical Society some years ago passed a resolution stating that "one of the most effective means of lessening the intense heat of the summer months and diminishing the death rate among children is the cultivation of a sufficient number of trees on our city streets." Aside from their physical influence which is hardly so great as is popularly believed, the presence of numerous small parks situated in the dense parts of the large cities has been found to actually diminish the number of criminal acts. Their quiet shade exerts a beneficial effect upon the overwrought nerves and in the words of the poet:

> There are green islands in the city sea,
> Where all day long the endless laboring waves
> Beat, yet destroy not and their quiet saves,
> How many a heart grown sick with memory.

Trees and parks do far more than add to the beauty of a city.

Just as the national park idea grew from the efforts of a few nature lovers, so has the city park and shade tree movement started from the efforts of public-spirited citizens who love green trees and worked for their preservation within city limits.

During the early nineties shade tree commissions were established in some of the Eastern cities and while their efforts lacked the directness and effect of later work, the real shade tree campaign in this country dates from about this time. Massachusetts, New Jersey and Pennsylvania lead in tree and park work, and while as a nation we lag behind many foreign countries, a splendid

start has been made. Our national capital—practically the only city in the country laid out according to a definite plan, made ample provision for drives, parks and the planting of trees and as a consequence Washington is beyond doubt the most beautiful city on this continent.

To have city forestry as it is called—although forestry is really raising trees for timber rather than for shade—properly carried out a regular organization in charge of trained men is necessary. The striking absence of shade trees along the principal streets of our larger cities is not alone the result of the mania for tree cutting so prevalent a few years ago, but also to the fact that trees in the cities are living in very difficult surroundings.

Adverse Conditions in the City.—Growing under natural conditions in the forest a tree may be crowded a little by its fellows but yet its roots have plenty of room, the rain that falls is quickly absorbed by the porous water-holding wood loam and the mulch of leaves and twigs in its decay releases plenty of food for the proper nourishment of the trees. How different are the conditions in a city! Where not paved with asphalt or stone blocks the streets are surfaced with a macadamized layer which will not permit any air or water to penetrate, and on the other side the pavement built in most cases close around the tree completes the airtight ring of stone and concrete. Unless there is a lawn between the sidewalk and houses the root system is forced to exist in very narrow quarters and is compelled to do with a minimum of water and air, for roots as well as leaves need air. Even the air is not at all suited to tree growth, for while human beings can survive the dust and soot-laden

air, trees find it quite difficult. The fine dirt from the pavements tends to clog the "stomata," the tiny breathing pores on the under side of the leaves, so that the leaves, the stomachs of the tree, find it hard to digest the food which is brought to them. The above explains why trees in the city often die from no particular disease or attack of any kind. In addition, by lowering their power of resistance these adverse conditions make trees much more subject to insect and fungus attacks. The forester must know the habits and resistance of his trees in the forest and in the same way the city forester or arborist, as he is sometimes called, must know which trees will survive in a given location.

Duties of a City Forester.—While the training received at the average forestry school is intended to fit men for tending timber forests, yet many such men have gone into city forestry work because they knew the life habits of trees. When the need of officials to look after trees was first felt by the cities, men were often chosen for political reasons but on account of the expert knowledge required it was soon found that technical training was absolutely necessary. On account of the length of time it takes to grow a tree, mistakes are extremely costly. If the wrong kind of tree is planted or if not enough growing space is given when trees are set out along a sun-beaten street much valuable time is lost, hence a well trained city forester can save much time and money. At present many of the men in direct charge of shade tree and park work are possessed of both technical training and experience. Several institutions in the East are educating men along these lines and in the best of them a thorough course in landscape engineering is given, so that the entire problem of construction and maintenance of a shade tree or

park plan may be under expert supervision from the beginning.

The duties of a city forester are many and varied. When work of this kind is begun one of the first things usually done is to take a census of all the shade trees in the city on a map showing the streets and blocks. Each tree is plotted on this map and its species, condition and distance from the curb, sidewalk, other trees, etc., is shown. With such a map in hand accurate information concerning streets and districts is available so that a beginning can be made where most needed.

Choice of Trees.—Another part of their work is the establishment of a municipal nursery where planting material for parks, playgrounds and streets can be raised for much less than private nurserymen would charge. The laying out of such a nursery and the propagation of species suited to the local conditions require a great deal of technical knowledge. The choice of trees for city planting is a question which requires a great deal of thought for trees, like human beings, have their peculiarities which may make some of them quite unfit for shade or park purposes. In the past many streets have been planted with trees that apparently were desirable only to find out thirty or forty years later that they possessed certain habits which made them objectionable. Among such undesirable trees the following might be mentioned:

The Silver Maple.—Fast-growing but very brittle and easily broken by wind or sleet. Grows in a straggly fashion; is comparatively short-lived and subject to insect and fungus attacks.

The Carolina Poplar.—Possesses all the above objectionable points and in addition has the disagreeable

habit of sending its roots into drains and sewers in search of water with the result that the sewage is forced back into the house. In many cities the planting of poplars in the streets has been forbidden by law.

Box Elder.—The box elder is likely to be ill-shapen and to suffer greatly from insect attacks.

Catalpa.—The catalpa is objectionable on account of the litter it drops.

Horse Chestnut.—This tree also litters the ground beneath and is quite likely to become a menace to passers by on account of its tendency to split and break. Practically all fast-growing trees are short-lived and are apt to be brittle. Such trees may be used for special purposes but should be followed by more desirable individuals.

American Elm and Hard Maple.—Certain trees like the American elm and hard maple are beautiful shade trees but on account of insect enemies should not be planted in certain regions. Throughout southern New England the elm can hardly be kept alive without one or two sprayings each spring with lead arsenate to kill the elm leaf beetle, while the frequent attacks of the maple borer make many beautiful round-headed sugar maples unsightly in a very short time. The use of such trees must depend upon local conditions.

Norway Maple and Plane Tree.—One of the most popular trees for street planting today is the Norway maple. It is a compact tree with round dense crown having foliage that is a dark rich green. It is comparatively free from attack. Another desirable tree is the Oriental sycamore or plane tree. Not only is it a rapid grower but it is comparatively long-lived which makes it one of the best for street planting. Such trees as the European linden and certain of the oaks—

red, pine, white and scarlet oaks—white ash and tulip poplar are also desirable—and the choice depends upon the location, soil and particular planting problem to be solved. For a street of average width the city forester would use one type of tree with a given spacing while on the narrower street another kind would be needed to give the ideal appearance. The forester must know the habits of his trees in order to make the proper choice.

Need of Public Sentiment.—Perhaps the most important part of a city forester's work is to arouse the enthusiasm of the citizens and secure their support. In a government like ours where the laws are made by the people if a regulation is passed which is not popular it does little good because it rarely is enforced. So unless the majority of citizens are convinced that shade trees must be protected against telephone lines, advertising signs, etc., that old trees should be sprayed and watered, and new streets should be planted up, the best of laws will be of little value. Proper legislation must be enacted and enforced. That he shall superintend the planting operation goes without saying, because properly to prepare a hole for planting the city tree is a nice piece of work. From two to five cubic yards of fresh loam must be put in the hole since the compact soil of the city would soon choke the tree; the roots must be properly pruned to remove broken or diseased parts and the top must be cut back to balance the decreased root system, and finally a mulch must be placed around the base of the tree and a metal guard put in place to protect against gnawing horses and passing vehicles.

The moving of large trees may require his attention from time to time, for while as a rule the smaller the

tree to be moved the better the result in some cases large trees ten to twelve inches in diameter must be planted along an avenue or in a park to give immediate results. In such cases the ground is dug away from the roots with great care, leaving a ball of earth and roots eight to ten feet in diameter. This tree is then carried on a specially constructed truck to its new position, where a larger hole partially filled with rich loam has been prepared. By root pruning these trees a year or two before they are to be transplanted much better results may be obtained.

The general care and upkeep of the city's trees of course are his concern. Trees must be sprayed with poisonous solutions to kill the army of leaf-eating insects which may consume all the leaves of a large tree in a short time. So serious have become the attacks of some of these pests that many cities have purchased high-power spraying trucks which will throw a fine spray of the poisonous material to the tops of the highest trees. Such measures are necessary not alone on account of the unsightly appearance of the leafless tree but also because several such attacks will kill the most vigorous specimens. Throughout New England countless elms are killed each year by the attack of the elm leaf beetle, while the presence of the imported moths in Massachusetts makes it necessary to spray large areas of wood land.

Tree Surgery.—The pruning of trees and the filling of cavities, often spoken of as tree surgery, are phases of city forestry which need expert knowledge. Far too much of this work has been done in our American cities by men whose only qualification was assurance. The result has been tree butchery plus a large bill for services rendered. The proper pruning of trees requires

a knowledge of how each kind of tree grows naturally and an attempt to force a tree to assume an unnatural shape is a waste of effort.

Tree surgery is perhaps the part of esthetic forestry with which the public is most familiar on account of the immense amount of advertising that has been done. To do good work, a knowledge of plant physiology, how the tree grows, what causes decay, etc., are necessary. Yet there are numerous firms doing work of this kind employing men none of whom, from the proprietor of the business down, knows anything at all about the fundamental principles of tree growth. In addition to carelessness a large amount of dishonest work has been done such as throwing in brick and loose stone into a large tree cavity, and coating the face with cement, making it appear like a solid mass of concrete. So many people have been deceived by the claims of such firms that in some of the States the college of forestry or State forester has sent out warnings against them. They not only collect large sums for work poorly done but the trees are left in worse shape than before.

When it is realized that a city forester on assuming office may take charge of twenty-five to thirty thousand trees of all kinds and conditions, the amount of this kind of work that is thrust upon him is enormous. The cultivating and watering of the city trees during periods of drought must also receive his attention, for many progressive cities are watering their trees every week or ten days. In addition to the above the planting of shrubs in parks, the development of new playgrounds, may be added to his work so that his position is one of great activity and responsibility. In all his undertakings his success will depend on personality and enthusiasm as much as on technical

training since people as well as trees must be handled. One of the best known men in this line of work attributes his success to the schoolchildren of his city. In addition to lecturing before men's and women's clubs he has enlisted the interest and enthusiasm of the younger citizens in the schools. Several hundred shade tree clubs were formed and each club took charge of several score of shade trees and watered and cultivated them carefully during the hot summer season. Aside from the actual service rendered the spirit aroused was especially valuable.

Communal Forestry.—In the New England States where the town—corresponding to a Western township—is the unit of government there is often an official whose work includes shade tree work, fire protection and moth suppression besides. This town tree warden is a man of some importance and should have considerable forestry training, for in some of the States, like Massachusetts, knowledge of the life history and habits of the gypsy and brown-tail moth is necessary. Under men of this type would come the management of communal forests, when such forests, owned and operated by the towns and villages are common throughout the country.

This ownership by the community of tracts of timber land is one of the most promising possibilities of forestry. In Germany and Switzerland many of the small towns own communal forests from which a substantial revenue is obtained. Massachusetts has established fifty-six such forests and doubtless other States will take this method of adding to their revenue and at the same time greatly improving the surroundings by transforming waste land into cool beautiful forest land.

Aside from the value of shade trees in making our

towns and cities more attractive and livable, their influence on economic forestry—the raising of trees for profit—cannot be overlooked. Fully two-thirds of our population live in cities where trees in groups or forests are not a part of the landscape and consequently their interest in trees is slight. If such citizens can be interested in the tree that stands before their door, progress has been made, for from interest in a single tree to trees in the forest is but a short step. It is felt that shade tree work is an important part in the movement toward awakening active sympathy for our national forest policy among the city dwellers of our country. Beside adding to the comfort and well-being of our present-day communities the city forester is also rendering service to the future generations who will enjoy the fruits of his labor.

CHAPTER XIV

THE FUTURE OF FORESTRY IN THE UNITED STATES

The development of forestry in this country can be likened to the growth of a tree. Commencing in Colonial times many seeds were sown in the form of warnings and prophecies concerning our vanishing timber supply but the seed did not germinate until 1876 when a Forest Agency was established in the Department of Agriculture. Owing to limited popular interest little apparent progress was made but as in the case of many trees a good root system was being developed preparatory to later rapid growth. Since fifteen years ago when Colonel Roosevelt became President the amount of land within our forests has been greatly increased and rapid strides have been made in the protection and development of the national forests. Private owners are taking notice of the work done by the Federal Government and while a start has been made there is still much to be done.

Americans often pride themselves upon their ability to achieve remarkable results in a very short time. While undoubtedly we have developed our country with great speed yet in spite of our rapid growth we are still a long distance behind some of the European countries in the management of our woodland. They were forced by necessity to care for their wild and mountainous land and consequently have brought their untillable areas to a high state of cultivation. Not only do the governments of such countries as France, Switzerland and Germany realize the importance of

protecting and improving their state forests, but the private owner considers his little woodlot worthy of care and attention. As a result the forests in these countries are unusually well kept and free from damage so that a net revenue ranging from one dollar and fifty cents to six dollars per acre per year is obtained. The awakening of interest among the private timber land owners in this country is the great need at present for only one-fourth of the forest land and one-fifth of the standing timber is owned by the Federal Government and the States. Unless the owners of this great bulk of our timber supply can be induced or assisted to practice some sort of forestry upon their holdings the future generations face a serious shortage of desirable forest products.

Forestry at Home and Abroad.—The true situation is of course that the American lumberman regards harvesting of the forest crop as a business, and rightly so. He cannot afford to take steps to perpetuate the nation's supply of lumber which would reduce his profit to the vanishing point. At a recent gathering of lumbermen a remark was made concerning the great waste in American logging; that only forty per cent of the tree reached the consumer in contrast to the situation in Germany where tops, branches and even stumps were sold. In reply one of the lumbermen stated that the amount of waste was not the fault of the lumberman, but rather market conditions were to blame; that the average timber operator would be only too glad to sell stumps, tops and branches and would even sell the holes the stumps came from if there were a demand for them. We simply cannot afford to do things that the average foreign forester considers necessary.

While there undoubtedly has been unnecessary waste in our logging, the chief difficulty has been in finding a market for the inferior grades of timber. When a financial panic hits the country or the lumber production becomes too great, the prices of lumber shrink until the knotty boards which can be sawed from the tree tops do not bring even enough to pay for their making. The only thing that can be done then is to leave them in the woods. This means waste, of course, but until the prices of wood products have risen to the point where it will pay to use such material, it must be left to rot on the ground.

Forest Taxation.—One of the great drawbacks to lumbering in the past has been a high rate of taxation. When timber land had little or no value and the tax rate was low an owner could hold his forest until a good price was to be obtained for his trees and then, if the kind of forest permitted, he could cut out only the best individuals, reserving the smaller ones for another crop. Much of the forest land in Maine has been cut over three or four times.

When taxes are high, however, the owner of timber land is compelled to harvest his crop to avoid loss and in some of the Western States where the forest counties levy a tax of five to six per cent per year on the full value of the standing timber the country is soon cleared of its valuable forests as a result of the high taxation, since the taxes would soon eat up the profit. If a woodlot is taxed once each year, the timber crop is taxed from forty-five to sixty times during its life whereas field crops are taxed only once. The ideal way of taxing forests which is being adopted by some of the States is to allow forest land to remain untaxed until the timber is cut and then when he receives the

money compel the owner to pay about ten per cent of his selling price. This method permits the owner to pay when he is best able to do so. With just tax laws and increased fire protection the raising of timber will be both safe and profitable.

Forestry Today.—During the early years the practice of forestry was confused by many with the park and playground idea. Many hardheaded business men thought forestry foolish because they had been told that the forester's motto was, "Woodman, spare that tree." The last few years have cleared up the real meaning, and as soon as it was known that forestry meant using the forest in a practical way and harvesting crops of timber from non-agricultural lands, much more interest and support was received. Forestry is essentially practical and while every forester loves the woods for their beauty and grandeur, and appreciates the indirect influences in harboring game and serving to refresh and rebuild the weary, nevertheless he believes that these ends may be obtained without locking up the wood land. Such is the case abroad, for the Black Forest attracts thousands of tourists each year; the shooting it furnishes is unexcelled in any part of Germany and yet profitable crops of timber are cut each year from the mountain slopes.

The present situation regarding forestry in the United States is that out of a total of 1,900,000,000 acres within our boundaries, about 545,000,000 acres are covered with forest. This area contains approximately 2,500,000,000,000 board feet of lumber of which about 40,000,000,000 board feet is used as saw timber each year and for all purposes about 23,000,000,000 *cubic feet* is cut. In case it might seem that the supply of timber now on hand is so large that we could never see the last of it,

and values of timber discussed in detail. The results in most States have been decidedly successful, for the wide-awake citizen of today, wherever he may live, knows what forestry is and what it is trying to do and the State forestry departments are receiving larger sums of money to carry on the work.

Outside of water companies who find the practice of forestry adapted to their needs—for pure water is their prime object and forest cover secures this splendidly while tillage and fertilization put agriculture out of the question—and a few favored estate owners who have land they cannot otherwise use, the raising of timber by the private owner is not very feasible. This is particularly true of the small woodlot owner. The trouble is that the owner of twenty to thirty acres even if acquainted with the best method of handling his forest crop, cannot sell his products to advantage on account of the small quantity he has to sell. A method of helping him dispose of his material will cause him to regard forestry as worth while and already the Forest Service and one of the State colleges of forestry are working upon a scheme for helping the small wood land owner market his products at a profit. When it is realized that nearly 200,000,000 acres of wood land are owned in connection with farms, the necessity of making the practice of forestry desirable to this kind of owner is clearly seen.

Another possibility of the future is communal forestry —the raising of timber by towns and villages. This type of forest is quite common in Europe and it is no unusual occurrence to find the town forest nearly if not quite paying the running expenses of some of the smaller villages in Germany. The Sihlwald, the city forest of Zürich, Switzerland, has been owned by that

Courtesy W. S. Carpenter

A Forest View

The permanent prosperity of the United States depends upon the right use of all our resources, including agricultural and forest soils. The protection and proper management of our nation's forests should be demanded by every patriotic and far-sighted citizen.

community continuously since the middle of the ninth century. From the 10,000 acres it contains an annual revenue of $70,000 is obtained, which materially lightens the amount to be raised by taxes. Countless towns in the Eastern States could acquire nearby tracts of waste land, plant them and use them as combination parks and forests and from this investment the coming generations would derive a great deal of pleasure and profit. In addition to beautifying areas now waste and idle such forests would stimulate better forestry among nearby private owners. Massachusetts with its fifty-six communal forests has made a splendid start and other States could well follow the example set by the Bay State.

This close utilization of non-agricultural land is only a part of the programme that must be carried out during the coming years, for with the population increasing by leaps and bounds the tillable lands must be economically handled in order to feed the future inhabitants. At the present rate of increase, by 1950 the agricultural portion of this country will be enlarged by 1,000,000 acres and then would include nearly eighty per cent of the total land surface of this country. In the same way the land which is too steep, too stony or too dry for field crops must if possible be kept producing timber harvests in order that books, fuel, and cheap shelter be provided for the citizens of the future. The Federal Forest Service has blazed the way by showing that large areas of forest land can be effectively managed and well protected. The fact that the National Forests are not yet self-sustaining is partially due to the fact that the Government-owned timber land is so remote from the markets—the far-seeing lumberman obtained the best and most accessible timber, and Uncle

Sam had to take what was left—and partially to the fact that the Forest Service does not care to force its timber on the market and compete sharply against the private owner. The management and protection are remarkably successful and the profits will be reaped by the coming generation. China and Syria have often been used to illustrate how great reduction in forest cover may cause an approach to desert conditions and while no doubt the results of deforestation may have been overdrawn it is generally believed that no less than twenty to twenty-five per cent of a country should be covered with trees in order that a seasonable climate be maintained. Some investigators claim that could the use for forest products be dispensed with, forests would still be necessary on account of their indirect benefits. Since forests are indispensable, the practice of forestry will not diminish in importance but with the growth of our country will assume its place as a profession not only highly honorable but one absolutely essential to the permanent prosperity of the nation.

PART II

CHAPTER I

TREES AND SHRUBS

JUST as a farm community is made up of cattle, sheep, and chickens, as well as men and women, so must herbs and shrubs be considered a part of the forest. It is all the life found in and upon the soil of a given location that composes the forest; trees, shrubs, herbs and grasses are all parts of the forest community.

To recognize all the members of a forest community is quite difficult and as a rule only the most expert botanists and dendrologists can call all the shrubs and trees by name. To know the most important citizens, however, gives much additional interest to walks in the woods, for it is like recognizing an old friend when a familiar pine or oak is seen. Not to know the more common trees and shrubs makes a nutting trip or scout hike like a stroll in an absolutely strange town where no familiar faces are noticed.

The total number of tree species in the United States is over five hundred of which about one hundred and fifty are used to some degree as lumber. Each forest region has its dozen or score of important trees which may be easily recognized and if these are known the remainder can be easily learned later.[1]

The usual method of identifying our trees is by means of leaf, bark and general form while in the winter time

[1] On account of the large number of trees and shrubs in the United States, it is impossible to cover all of them in a book of this kind. A few of the most important have been selected from

the trees which shed their leaves may be recognized by means of their buds. To one familiar with the trees from childhood none of these means of identification seems important; the tree is a poplar because the general appearance looks like a poplar, just as one recognizes a boyhood friend by his appearance from a long distance and does not have to examine him closely to see if his hair is black or brown or look at the color of his eyes to decide whether it is Dick or Ralph. To the novice, however, these finer points are necessary until one becomes thoroughly familiar with the form, method of branching, color of bark, etc.

The trees common to the United States are divided into two classes:

I. Gymnosperms, naked-seeded trees which bear their seed on the face of a scale. The fruit is a woody cone except in the case of junipers and yew where it is berry-like. This class is much older and less specialized than the second class.

II. Angiosperms, where the seeds are borne in a closed receptacle—not a cone. This class contains the broadleaf or hardwood trees.[1]

each region and their characteristics described so as to make their identification easy. If further knowledge is desired the State Botanist will doubtless be able to name several books of reference, covering the region in question. In many cases the State Forester publishes a small booklet describing the local trees in a popular way. The best reference book for tree identification is the "Manual of the Trees of North America" by Charles S. Sargent.

[1] By hardwoods the broadleaf or deciduous trees are meant; and softwood is used to characterize trees of the evergreen class regardless of the hardness of their wood. This differentiation is accepted by the lumberman regardless of the fact that certain so-called hardwoods like poplar have wood that is much softer than certain softwoods like the longleaf pine.

I. GYMNOSPERMS

CONIFERS AND YEW

THE PINES[1]

Leaves needle-shaped in bundles. Leaves 2-5 in a bundle; remain on the tree the year round.

WHITE PINE *Pinus strobus*	RED PINE *Pinus resinosa*	PITCH PINE *Pinus rigida*
LEAVES In bundles of 5, in length 3″–4″. Bluish green in color, flexible.	LEAVES In bundles of 2 each, 5″–6″ long, soft and flexible. (Austrian pine, also two-leaved, has much stiffer needles.)	LEAVES In bundles of 3, short stiff, yellowish green, 3″–5″ long.
CONES 5″–7″ long, borne on long curved stalk.	CONES 2″–2½″ long, borne on short stalks.	CONES 1″–3″ long, borne on short stalk often in clusters, cone scales have prickles. Cones often remain 10–12 years on tree.
RANGE Maine to Minnesota; south along Appalachians to Georgia.	RANGE Maine to Minnesota; South to Pennsylvania.	RANGE New Brunswick south to Georgia; west to Tennessee.

[1] There are in all thirty-five native pines in the United States. Twenty-two hard pines, one red pine, and twelve soft pines. Two foreign pines are extensively planted throughout the east, the Scotch pine (*Pinus sylvestris*) and the Austrian pine (*Pinus austriaca*). Both have their leaves in bundles of two. The Scotch pine has needles from 1 to 1½ inches long, stiff with a grayish bloom upon them. The orange color of the bark of the smaller limbs and the upper trunk is very distinctive. The Austrian pine resembles the native red or Norway pine but its leaves are much stiffer. They are from 3 to 5 inches long.

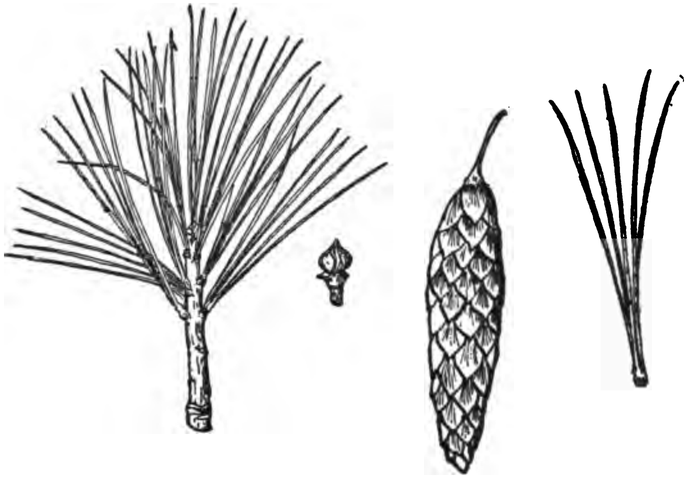


Fig. 1

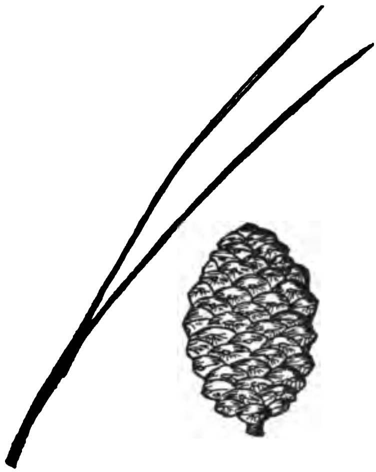


Fig. 2

Fig. 3

Fig. 1.—Leaf bundle, cone, bud, and branch of white pine.
Fig. 2.—Leaf bundle and cone of red pine (*Pinus resinosa*).
Fig. 3.—Leaf bundle and cone of pitch pine.

LONGLEAF PINE *Pinus palustris*	SHORTLEAF PINE *Pinus echinata*
LEAVES In bundles of 3; many clusters at end of branch, 8"–18" long, slender, flexible, dark green.	LEAVES In bundles of 2 and 3, slender, flexible, blue green, 3"–5" long.
CONES 6"–10" long borne on short stem, scales thin and flat, armed with short prickle.	CONES 1½"–2½" long, borne on short stems with thin scales rounded at apex and tipped with short prickles.
RANGE Virginia to Texas along the coast plain.	RANGE New York to Texas, thence north up Mississippi valley to Missouri.

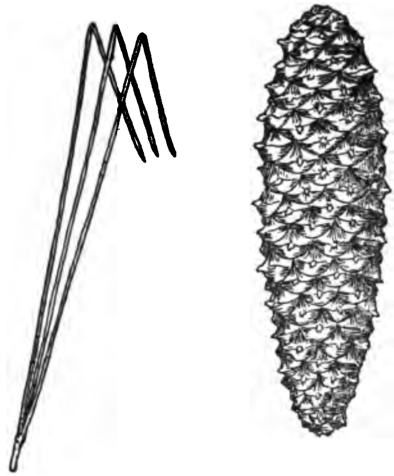


Fig. 4

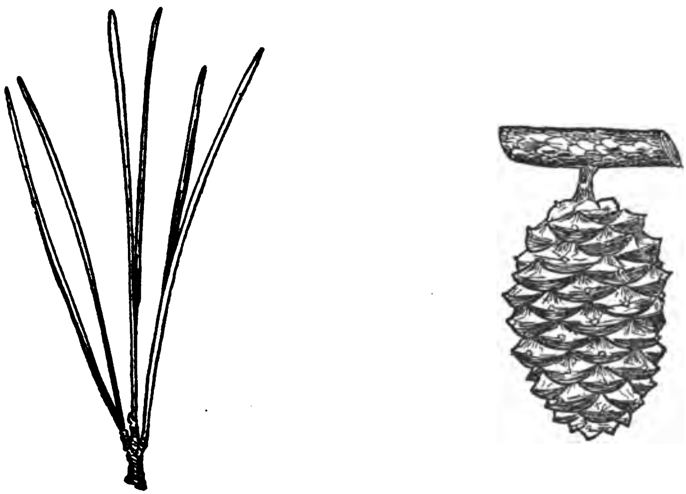


Fig. 5

Fig. 4.—Leaf bundle and cone of longleaf pine.
Fig. 5.—Leaf bundle and cone of shortleaf pine.

BULL OR WESTERN YELLOW PINE *Pinus ponderosa*	LODGEPOLE PINE *Pinus contorta*
Leaves In groups of 2 or in bundles of 2 and 3; in tufts at end of naked branches. 5″–11″ long, stout yellowish green.	**Leaves** In bundles of 2, yellowish green, usually about 2″ long.
Cones Short stalked, 3″–6″ long, bright green, scales thickened at unattached end, tipped with slender prickles.	**Cones** 1½″–2″ long. Quite persistent; many hang on tree unopened for 10–15 years.
Range From Washington to Mexico and from Pacific Ocean to Dakota, Nebraska, and Texas.	**Range** Alaska to California and Colorado.

Fig. 6

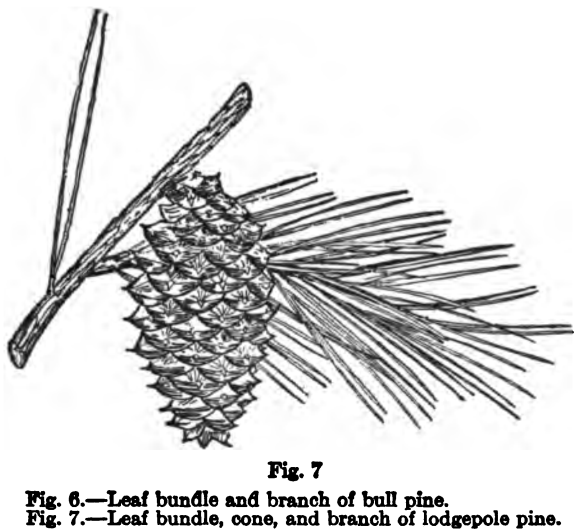


Fig. 7

Fig. 6.—Leaf bundle and branch of bull pine.
Fig. 7.—Leaf bundle, cone, and branch of lodgepole pine.

WESTERN WHITE PINE *Pinus monticola*	SUGAR PINE *Pinus lambertiana*
LEAVES In bundles of 5; from 1½"–4" long, blue green, much stiffer than Eastern white pine.	LEAVES In bundles of 5; stout and fairly stiff. 3½"–4" long.
CONES 5"–11" long with cone scales much thickened at unattached ends.	CONES Longest cones of any pines in the world, up to 18" long, borne at outer ends of branches.
RANGE From British Columbia south to California and mountains of Northern Idaho and Montana.	RANGE Oregon and mountains of California.

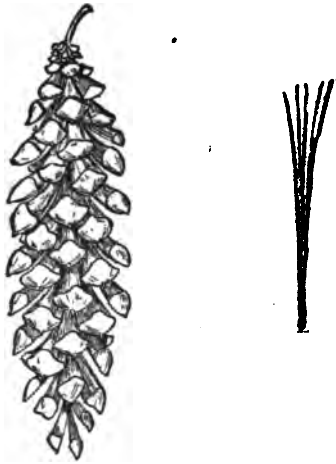


Fig. 8

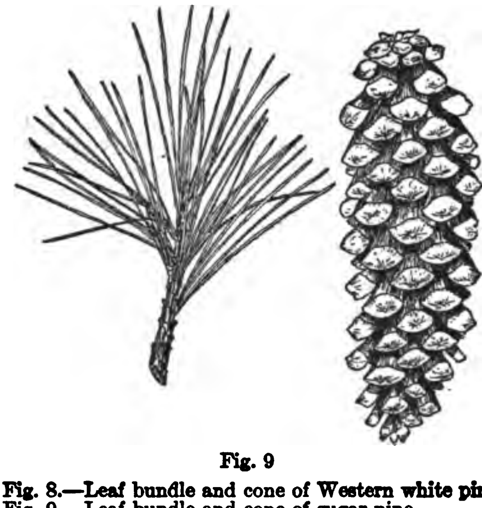


Fig. 9

Fig. 8.—Leaf bundle and cone of Western white pine.
Fig. 9.—Leaf bundle and cone of sugar pine.

LARCHES

Needles many in a bundle borne upon a short spur-like branch. Unlike most of the cone-bearing trees the larches shed their needles each autumn.

TAMARACK OR EASTERN LARCH *Larix americana*
Leaves Awl-shaped, borne in clusters on short spur-like branches, bright green in color. Turn yellow and fall in September or October.
Cones Small and rounded, ½"–¾" long, light brown in color.
Range Maine to Rocky Mountains. South to West Virginia and Illinois.

The two other larches found in the West differ from the Eastern species by having their cones more elliptical in shape with "bracts" (scales attached to under side of cone scales) extending beyond the cone scale.

Fig. 11

Fig. 10

Fig. 10.—Branch of Eastern larch showing leaves and cone.
Fig. 11.—Branch of Western larch showing leaves and cone with protruding bracts.

SPRUCES

Leaves not in bundles but scattered singly over the twigs. Leaves raised on small cushions which cause a roughness of the twigs after leaves have fallen.

RED SPRUCE *Picea rubens*
LEAVES 4 sided, ½″–⅝″ long, dark green, often with yellow tinge. Remain on tree 5–6 years.
CONES 1¼″–2″ long, borne on very short stalks, bright green before mature, light brown when ripe.
RANGE New England and New York, south to West Virginia and Tenneesee.

In addition to the red spruce of the North Woods there is the black spruce and cat spruce common to New England; the Engelmann and Colorado spruce of the Rockies and two others of little economic importance (seven in all).

Fig. 12.—Branch and cones of red spruce.

HEMLOCKS

Leaves flat, with tiny stalks and round at the tip.

EASTERN HEMLOCK *Tsuga canadensis*	WESTERN HEMLOCK *Tsuga heterophylla*
Leaves ⅓"–⅔" long, dark green with 2 whitish lines on under side.	**Leaves** ¼"–¾" long, very shiny, green on top with 2 whitish bands beneath.
Cones ½"–¾" long on slender stalk.	**Cones** ¾"–1" long, borne on twig (no stalk).
Range Maine to Minnesota south to Georgia.	**Range** Southern Alaska to Central California, east to Idaho.

There are four hemlocks in the United States. The two described above are of the greatest economic importance.

Fig. 13

Fig. 14

Fig. 13.—Twig and stalked cone of Eastern hemlock.
Fig. 14.—Twig and sessile cone of Western hemlock.

Leaves without stalks; twigs not rough, leaf scars flat. Leaf scars large; cone scales fall away from central axis.

WHITE FIR *Abies concolor*
LEAVES In 2 ranks 1″–2″ long, twisted at base, blue green in color.
CONES 3″–5″ in length; borne erect with broad flat scales.
RANGE Southern Colorado to mountains of California north to Oregon and South to Mexico.

In addition to the white fir which is frequently used for ornamental planting in the East and in Europe there are eight firs in the United States (nine in all).

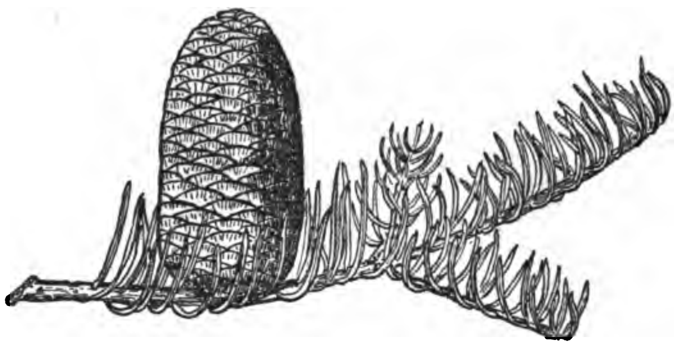


Fig. 15.—Twig and cone of white fir.

THE OREGON FIR

Leaf scars small, leaves not twisted, soft.

DOUGLAS FIR *Pseudotsuga taxifolia*
LEAVES ¾″–1¼″ long, dark yellow green.
CONES 2″–4½″ long with thin scales. Bracts extending sometimes ½″ beyond cone scales.
RANGE From Canada to Texas; from Rockies to Pacific Coast except in Great Basin.

Illustration shows relation between "bracts" and cone scales. There are two members of this genus in the United States.

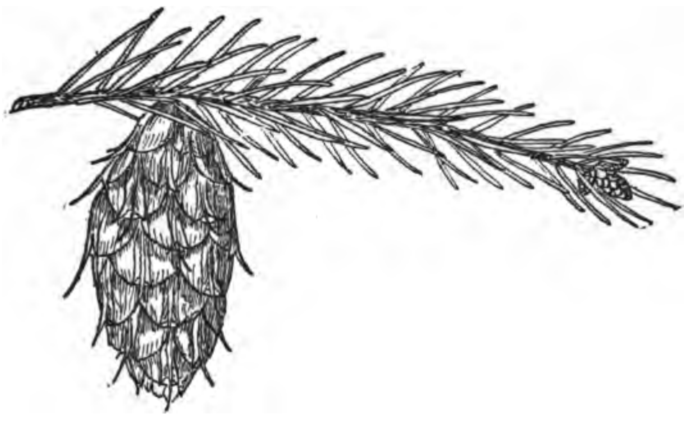


Fig. 16.—Twig and cone of Douglas fir or Oregon pine; showing protruding bracts.

SEQUOIAS

Leaves attached by means of broad bases which run down the twigs.

REDWOOD *Sequoia sempervirens*
LEAVES In 2 ranks; both needle-like and scale-like leaves ¼"–¾" long.
CONES ¾"–1" long, scales broadened on end.
RANGE Southern Oregon to Central California, rarely outside of fog belt.

Fossil remains of sequoia are found all over North America, Europe and Asia, but at present there are only two species now remaining of the former sixteen. They are the redwood and the big tree (*Sequoia Washingtoniana*), both found in the United States and largely in California.

Fig. 17.—Branch, flower, and cone of the redwood.

THE BALD CYPRESS

Leaves two ranked forming flattened branchlets; deciduous.

BALD CYPRESS *Taxodium distichum*
LEAVES ½"–¾" long, bright yellowish green, turning a dull brown in the autumn before they are shed.
CONES Usually borne in pairs, globular in shape.
RANGE Delaware to Florida and Texas. North up the Mississippi River to Southern Illinois.

The presence of "knees," which are stout pointed outgrowths from the roots, is most characteristic of this species of tree.

Fig. 18.—Branch and cone of bald cypress.

THE JUNIPER

Fruit a berry; not a woody cone. Leaves arranged on all sides of the twig, scale-like.

RED CEDAR *Juniperus virginiana*
LEAVES Scale-like, $\frac{1}{16}''$ long, dark bluish green, occur in opposite pairs.
FRUIT A berry having a dark blue color at maturity. Within the resinous flesh are found 1–2 seeds.
RANGE New England to Dakota and Kansas. South to East Texas.

There are eleven junipers in the United States, all having light fragrant woods of more than average durability.

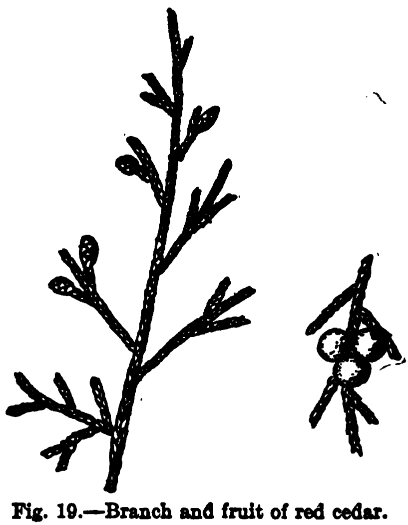


Fig. 19.—Branch and fruit of red cedar.

II. ANGIOSPERMS

THE HARDWOODS

In contrast with the previous naked seed family called the gymnosperms, the broadleaf trees or hardwoods belong to the family (angiosperms) whose seed is borne in a closed cavity.

While the hardwoods form only about one-fifth of the total annual cut of lumber yet their relative importance is greater than this proportion would indicate. Furniture, flooring, agricultural implements, wagon stock, etc., all draw the bulk of their supplies from the hardwood forests. The habit of the so-called hardwood group to shed their leaves in winter makes a knowledge of their buds essential if the tree is to be recognized the year round, but to a beginner, the ability to identify the tree in its summer condition is the most important.

As it happens the list of trees as arranged by the scientist is headed by some of the trees dearest to the heart of the average boy, for some of the most common and best known nut-bearing varieties are first in order.

THE WALNUTS

This family contains not only the black walnut and butternut but also the toothsome shagbark, the mockernut, etc.

BLACK WALNUT *Juglans nigra*	BUTTERNUT *Juglans cinerea*
BARK In mature trees dark brown, deeply ridged. 2″–3″ thick.	BARK Thin, light gray, divided into broad ridges.
LEAVES 1–2 feet long with 15–20 leaflets, 3″–3½″ long.	LEAVES 15″–30″ long, made of up 11–17 leaflets 2″–3″ long.
FRUIT A globular nut encased in a yellow green husk.	FRUIT A cylindrical nut encased in a sticky husk covered with brown hairs.
RANGE Western Massachusetts to Michigan, south to Florida and Texas.	RANGE New England and Dakota, south to Georgia.

The walnut family can always be separated from the hickory family by the fact that the pith in the former is split into thin brown plates while the pith of the hickories is solid. By cutting across a twig the family can be determined, while the bark or leaves will separate the walnut from the butternut. There are two other walnuts in the United States one being found in Colorado and New Mexico, the other in the California coast region.

Fig. 20.—Nut with and without husk, flowers, and compound leaf of black walnut.

THE HICKORIES

SHAGBARK OR SHELLBARK *Hicoria ovata*	PIGNUT *Hicoria glabra*
Bark Gray in color. On mature trees broken into long curved strips loosely attached to tree.	**Bark** $\frac{1}{3}$"–$\frac{3}{4}$" thick, light gray, usually quite firmly attached to trunk.
Leaves 8"–14" long, 5–7 leaflets having no stalk.	**Leaves** 8"–12" long with 5–7 or 9 leaflets with very short stalks.
Fruit Oblong nut with thick husk splitting to base, meat unusually sweet.	**Fruit** Nut variable in shape. Often falls while still encased in husk; meat either bitter or sweet.
Range Southern Maine to Central Minnesota, south through Eastern Texas to Western Florida.	**Range** Dry uplands of practically same region as shellbark. However, ranges farther south.

There are altogether eleven species of hickories found in the United States. The pecan hickory furnishes a nut of great value and is being planted in large numbers in the Southern States.

Fig. 21.—Compound leaf, bud, fruit, and flower of shagbark.

THE ASPENS

TREMBLING ASPEN *Populus tremuloides*	BIG TOOTH ASPEN *Populus grandidentata*
Bark Thin, bitter to the taste, pale green or nearly white, often marked with circular bands of wart-like growths. Bark is quite dark near the ground.	**Bark** Smooth, light above, brown near ground, no bitter taste.
Leaves Oval, pointed with small teeth. Stems flattened from side to side, causing the leaves to flutter in the slightest breeze.	**Leaves** Broadly oval, 3″–4″ long with large teeth.
Range From Hudson Bay to Alaska, to Lower California. It is the most widely distributed tree in America.	**Range** Southern Canada to Northern Minnesota. South along the Appalachians to North Carolina.

The poplar family is composed of nine members besides the two described above. The trees are fast-growing and short-lived as a rule. On account of their light seed, liberated attached to flecks of down, they are carried long distances on the wind. In the North they are likely to form dense forests following extensive fires. Their rapid growth and the ease with which they may be reproduced from cuttings make them valuable to plant for wind breaks where quick protection is needed.

Fig. 22.—Leaf, flowers, and fruit of trembling aspen.

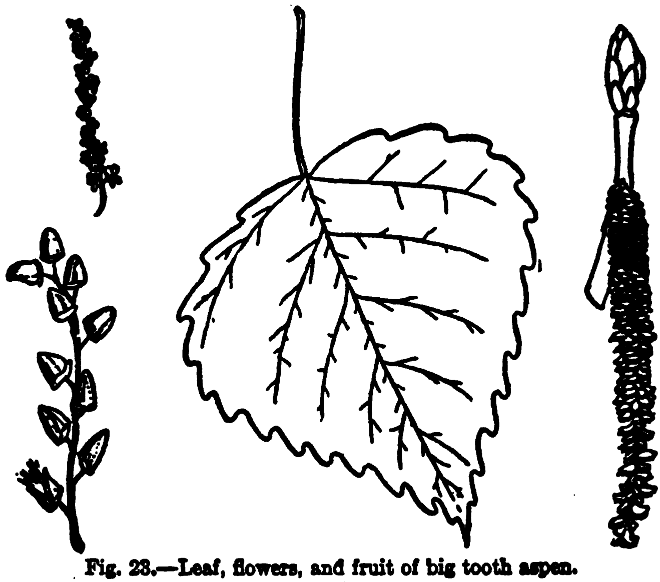


Fig. 23.—Leaf, flowers, and fruit of big tooth aspen.

WILLOWS

The willow family is the most widely distributed of all the trees which inhabit the Northern Hemisphere. It extends from the Arctic circle to the equator and is found in both the Old and New Worlds. The wood is soft, light and tough, but usually of little durability or strength.

The wood of willow warps considerably and while it furnishes a charcoal valuable in the manufacture of gunpowder it is of little importance in the lumber industry. The use of willow osiers for basket-making is growing in importance and in some parts of the country they are raised artificially in plantations called "willow holts." There are twenty-five willows of tree size in the United States and about fifty-four shrubs. Many foreign species, like the white willow, have been introduced from Europe and have become wild. At present as far as numbers are concerned the foreign willows are more important than the native species. The weeping willow, an introduced species, is often used for ornamental planting. Most of the American species are confined to low moist ground or to high elevations. As a family they are of little importance and no special effort is made to tell one kind from another.

Fig. 24.—Leaf, flower, and fruit of white willow.

THE BIRCHES

YELLOW BIRCH *Betula lutea*	WHITE OR PAPER BIRCH *Betula papyrifera*
Bark Light yellow and separating into thin narrow curly sheets. On older trees becomes dark reddish brown.	**Bark** Creamy white outside, pinkish tinge beneath separating into thin papery layers. Resinous and formerly used for canoes.
Leaves Leaves 3″–4½″ long by 1½″–2″ wide. Edge divided into 2 sets of teeth—large and small.	**Leaves** 2″–3″ long, 1½″ wide, generally oval in shape. Edge also double toothed.
Range Maine to Minnesota, south to Tennessee. More common in the North.	**Range** New England, through North Dakota to Northwestern Washington, as far south as Northern Nebraska.

BLACK OR SWEET BIRCH *Betula lenta*
Bark Dark lustrous, resembling bark of young cherry. Bark on twigs has pronounced taste.
Leaves 2½″–6″ long by 2″–3″ wide with sharp incurved teeth.
Range Maine to Central Iowa, south to Western Florida.

The birches in addition to yielding wood for furniture and interior finish also supply spools, shoe pegs, veneers, etc. There are ten species in the United States.

Fig. 25.—Leaf, flower, and fruit of yellow birch.

Fig. 26.—Leaf and flower of paper birch.

BEECH

The beech is called by the German foresters the "Mother of the Forest" on account of its tendency to enrich the barren soils with its fertile leaf mulch. The early Colonists, in selecting homesteads, chose level land upon which beech or maple was growing, as they knew the soil would be very fertile.

BEECH *Fagus americana*
BARK Thin, steel gray and very smooth.
LEAVES 2½″–5″ long, coarse teeth and with long slender points.
FRUIT A burr containing one or two triangular nuts.
RANGE Northern New England to Northern Wisconsin. South to Northern Florida and Eastern Texas.

There is only one kind of beech native to this country although there are several varieties of European beech planted for ornamental purposes. In Europe the beech nuts are highly prized for cattle feed and large droves of hogs fatten upon the beech "mast" in the German forests.

Fig. 27.—Leaf and burrs of American beech.

CHESTNUT

Another important nut tree is the chestnut. On account of its rapid growth, and its durability in contact with the soil the chestnut has been highly prized for fence posts, railroad ties, etc. The chestnut disease, due to a fungus called *Endothea parasitica,* seems to attack mature trees as well as young sprouts with great violence and already this valuable species has been largely killed in certain parts of its range. The future is decidedly uncertain but for the present the planting of any chestnut seems unwise.

CHESTNUT *Castanea dentata*
Bark Smooth and dark gray on young trees. On older trees becomes darker and divided into flat ridges.
Leaves Oblong, 6″–8″ long, 2″ wide, sharp pointed.
Fruit A burr covered with sharp spines containing 1–3 nuts.
Range Maine to Southern Michigan, to Central Alabama and Mississippi.

There is another member of this family—the chinquapin—found from Southern Pennsylvania to Florida and Eastern Texas. It is by no means an important tree.

Fig. 28.—Leaf, flower, burr, and nut of chestnut.

THE OAKS

The oak family is by all means the most important of all the broadleaf genera found in the Northern Hemisphere as over one-third the total cut of hardwoods is supplied by the various oaks. Of the fifty-two species found in the United States five are shrubs; twenty-three of the tree species belong to the white oak group and twenty-four to the black oak group. The distinctive feature of this genus is the fruit—an acorn—and the length of time it takes to mature this fruit divides the white from the black oak group. In the former the acorn matures in one year, with one minor exception, while with the black oaks two seasons must elapse before the fruit is mature consequently if a tree belongs to the black oak group it will have small acorns on the tree in the winter which will ripen during the next season.

BLACK OAKS

RED OAK *Quercus rubra*	BLACK OAK *Quercus velutina*
BARK Slightly ridged with pale grayish plates above, darker near ground. Inner bark pink.	BARK Dark with deep fissures, near ground breaks into small square plates. Inner bark yellow.
LEAVES 5"–9" long, lobed, with sharp point at end of each lobe.	LEAVES 5"–6" long and quite deeply lobed with sharp points. Rusty hairs on under side along ribs.
FRUIT Acorn 1"–1¼" long with shallow saucer (one-fourth length of acorn).	FRUIT Acorn with square shoulders ½–¾" long; saucer ½ length of the acorn.
RANGE Maine to Minnesota, South to Northern Georgia.	RANGE Maine to Minnesota, Florida Texas. Most prominent in the South.

There are in addition twenty-two members of the black oak family.

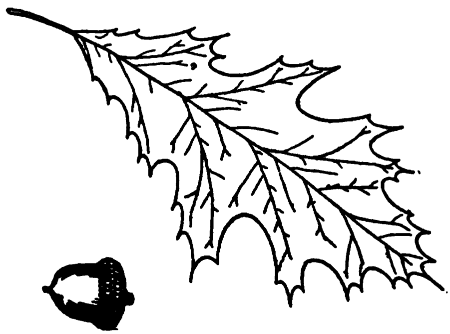


Fig. 29.—Leaf and acorn of red oak. The saucer of the black oak is much deeper.

WHITE OAKS

WHITE OAK *Quercus alba*	VALLEY OAK *Quercus lobata*
Bark Light gray, broken into thin flat scales. On old trees up to 2″ in thickness.	**Bark** Covered with small light gray scales tinged with brown. Up to 6″ in thickness.
Leaves Oblong, 5″–9″ in length with rounded lobes. Generally remain on branches well into the winter.	**Leaves** 2½″–3″ long, wedged shaped, with rounded lobes.
Fruit An acorn ¾″ long with rounded end; enclosed one-fourth its length in brown cup.	**Fruit** An elongated acorn 1¼″–2¼″ long. Cup one-fourth the length of the acorn.
Range Southern Maine to Minnesota, South to Florida and Texas.	**Range** Valleys of Western California.

In addition to above there are twenty-one members of the white oak family. From them is secured some of the most valuable woods of commerce.

Fig. 30.—Leaf, flower, and fruit of white oak.

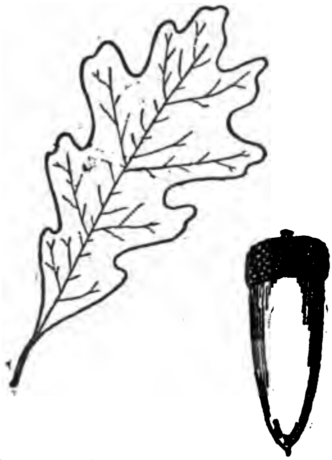


Fig. 31.—Leaf and fruit of valley oak.

THE ELMS

The elms, while not of great importance in producing lumber are very commonly planted for ornamental purposes. In certain parts of this country notably in the Northeastern States they form an important part of the landscape, and in many an old New England village the charm of the streets and the parks is largely due to the elms. It is a tree that is quite easy to distinguish.

AMERICAN ELM *Ulmus americana*
Bark Ashy gray, divided by deep furrows into broad ridges.
Leaves 2"–5" long with coarse teeth on the edges. Generally one-sided at the base.
Fruit A small winged seed which ripens and is shed in May before the leaves are full grown.
Range Maine to North Dakota, Texas to Florida.

In addition to this species there are four others found within the United States, the most important of which are the rock elm and slippery elm.

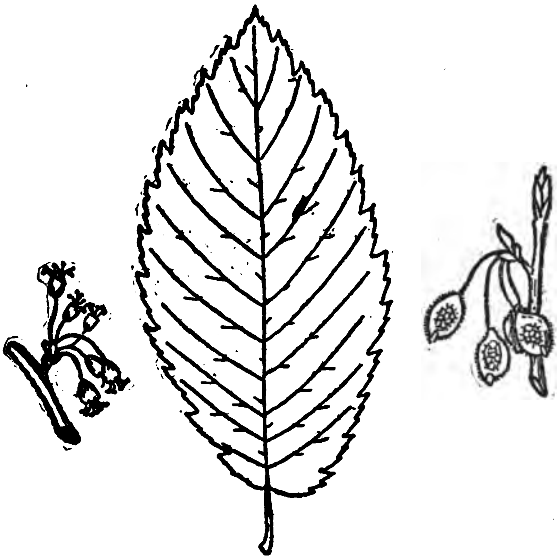


Fig. 32.—Flower, fruit, and leaf of American elm.

MAGNOLIAS

With the possible exception of the flowering dogwood there is no more beautiful tree native to this country than the flowering magnolias. In addition some of them furnish excellent lumber.

SWEET BAY *Magnolia glauca*
Bark Branchlets bright green at first, turning reddish brown to gray the second summer. Bark on mature trees thin and gray.
Leaves Oblong, 4″–6″ in length, bright lustrous green. In the South they remain with little change until the following spring.
Fruit A fleshy cone, 2″ long, dark red in color.
Range Massachusetts south to Florida, west Texas.

Flowers large (two inches to three inches), conspicuous, continue to open for several weeks in the spring. There are in all seven magnolias in the United States of which the cucumber tree (*Magnolia acuminata*) and the sweet magnolia of the Southern melodies (*Magnolia fœtida*) are the most important.

Fig. 33.—Leaf, flower, and fruit of sweet bay.

TULIP

Closely related to the magnolia is the tulip tree or tulip poplar, as it is sometimes called. This tree probably cuts as much high class lumber for its size as any tree we have.

TULIP TREE OR TULIP POPLAR *Liriodendron tulipifera*
BARK On young trees, smooth ashy gray, deeply furrowed—grayish brown on older trees; 1″–2″ thick.
LEAVES Apparently cut off square on end, with slight notches; length 5″–6″.
FRUIT A light oblong pointed brown cone 2½″–3″ long. Composed of many scales to base of which seeds are attached. Fruit often hangs on through winter.
RANGE Southern Vermont to Illinois; south to Florida and Arkansas.

There is only one member of this family in North America.

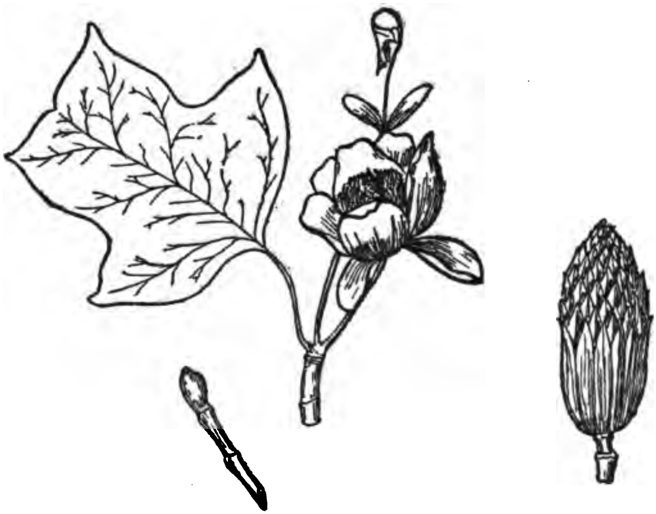


Fig. 34.—Leaf, bud, flower, and fruit of tulip poplar.

SYCAMORE

The sycamore or buttonwood tree while of comparatively little importance as a timber tree is nevertheless quite common and its unusual mottled or piebald bark makes it much more noticeable than it might be otherwise. It is said to be the tallest and most massive of the broadleaved trees of North America. There are three native sycamores while the European species is also extensively planted as a shade tree.

SYCAMORE OR BUTTONWOOD *Platanus occidentalis*
Bark Thin, the outer layers shedding from time to time, laying bare the thin light green or whitish under bark.
Leaves Broadly lobed, 4″–7″ long and oval, wavy edge with small points.
Fruit Very distinctive, a head or ball about 1 inch in diameter containing many seeds.
Range Borders of streams and lakes; Southern New Hampshire to Kansas, Florida and Texas.

Fig. 35.—Leaf, bud, and fruit of sycamore.

LOCUST

Of the three locust trees found in the United States only one, the black locust, is of any great importance. The honey locust belongs to another genus. All have compound leaves and fragrant flowers which are quite conspicuous.

BLACK LOCUST *Robinia pseudacacia*
Bark Dark brown, deeply furrowed 1″–1½″ thick on old trees; bright yellow inner bark which is often used for dyeing.
Leaves Compound, 8″–14″ long and have from 7–20 leaflets.
Fruit A smooth flat dark-brown pod containing from 4–20 seeds.
Range Originally found only in the Appalachian Mountains from Pennsylvania south to Northern Georgia. Now all over the Eastern United States; extensively planted in Europe.

Fig. 36.—Compound leaf and fruit of black locust.

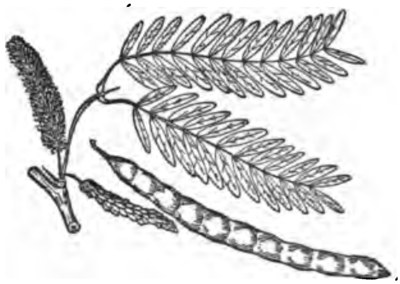


Fig. 37.—Leaf, flower, and fruit of mesquite.

MESQUITE

The mesquite is the important tree of the arid Southwest and its deep root system—forty to fifty feet—gives rise to the saying that "a man has to dig for his firewood," as the bulk of the tree is below ground. The wood is heavy and durable; the pods supply food to the Indians and are eaten by cattle and horses.

MESQUITE *Prospis juliflora*
Form A tree occasionally 40′–50′ high, but usually branching close to ground, may become 6″–10″ in diameter.
Leaves 3″–6″ long, compound, composed of 12–16 leaflets from 1″–2″ in length, from $\frac{1}{8}$″–$\frac{1}{4}$″ in width.
Fruit A pod 4″–9″ long growing in clusters; flat at first, later becoming ridged owing to tightening of husk in between the 10–20 seeds.
Range Southern borders of Colorado and Utah to Western Texas.

THE MAPLES

To the early Colonists the maples were trees of value. Their presence as a rule meant strong fertile land of high agricultural value; besides, sugar could be obtained from several of them. There are all told nine species of maple trees in the United States, of which the sugar maple is the most important from an economic point of view. The box elder and silver maple are both common, having been widely planted, but in spite of their rapid growth are considered undesirable for shade purposes as they are both very brittle.

SUGAR OR ROCK MAPLE *Acer saccharum*	RED MAPLE *Acer rubrum*	BOX ELDER *Acer negundo*
Bark Pale and smooth on young trees. Deeply furrowed and gray brown on older trees.	**Bark** Pearly gray on young trees; forming plate-like scales on older trees.	**Bark** Pale gray, divided into short thick scales $\frac{1}{4}''$–$\frac{1}{2}''$ thick.
Leaves Heart-shaped with round sinuses (notches) 3–5 lobes.	**Leaves** Five lobed with sharply pointed sinus. Edges have many teeth; leaves appear after flowers in spring.	**Leaves** Compound or 3 lobed leaflets with edges coarsely notched.
Fruit A samara (fruit with wing). Ripens and is shed in autumn.	**Fruit** A samara, ripens in early summer; fruit smallest of the maples.	**Fruit** A samara borne in dense clusters, ripening in early summer.
Range Maine to Minnesota; Florida and Texas.	**Range** Maine to Western New York; Florida and Texas.	**Range** From Canada to New York State through Virginia to California; south to Florida and Texas. Most common along streams. Frequently planted as shade tree in the West.

Fig. 38.—Leaf, flower, and fruit of sugar maple.

Fig. 39.—Leaf, flower, and fruit of red maple.

Fig. 40.—Leaf (compound), flower, and fruit of box elder.

BASSWOOD OR LINDEN

While the linden family is widely distributed over the north temperate zone there is only one of tree size —*Tilia americana,* the basswood—found in the United States. However, several European varieties are planted here for ornamental purposes.

LINDEN OR BASSWOOD *Tilia americana*
Bark Smooth and grayish brown on young trees. Deeply furrowed, light brown, and up to 1″ thick on mature trees.
Leaves Heart-shaped with notched edges 5″–6″ long, dark green above, yellow green and lustrous beneath.
Fruit Quite distinctive; nut-like, covered with a hairy coat and attached to a long stalk to a sail-like leaf.
Range Maine to Dakota; Texas to Northern Georgia and Alabama.

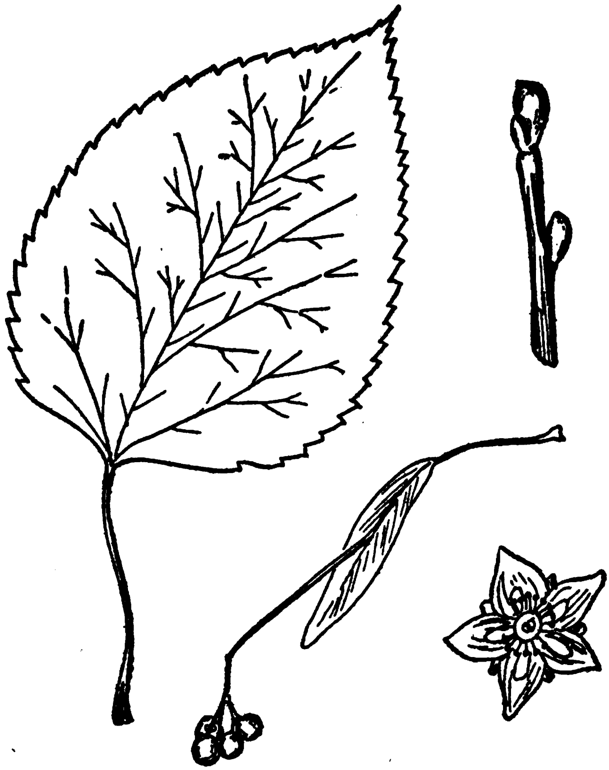


Fig. 41.—Leaf, flower, fruit, and bud of basswood.

ASHES

Of the seventeen kinds of ash found in the United States all but one reach tree size. Most of them, however, are of slight value commercially, the white ash being by all odds the most important.

WHITE ASH *Fraxinus americana*	BLACK ASH *Fraxinus nigra*	RED ASH *Fraxinus pennsylvanica*
Bark Dark brown, divided into ridges by deep fissures. 1″–3″ in thickness.	**Bark** Gray with slightly reddish tinge; ⅛″–½″ thick. Divided into large irregular plates.	**Bark** Brown, tinged with red, slightly furrowed.
Leaves Compound, 8″–12″ long; 7–9 leaflets borne on stalks.	**Leaves** Compound, 7–11 leaflets *without* stalks.	**Leaves** Compound, 7–9 leaflets borne on stalks.
Fruit A samara 1″–2″ long borne in clusters. Often hang on tree till mid-winter.	**Fruit** A samara from 1″–1½″ long.	**Fruit** A samara; seed long and slender.
Range Maine to Minnesota; Florida to Texas.	**Range** Found in swamps and along streams; Maine to North Dakota, Missouri and Arkansas.	**Range** Lowlands from Maine to Dakota; south to Florida and Central Alabama.

Fig. 42.—Leaf, flower, and fruit of white ash. Between leaf, bark, and fruit the most common ashes may readily be distinguished.

SHRUBS

The shrubs are the "little people" of the forest. They are woody plants which branch directly at the ground instead of combining all their growth into a single stem as do the trees.

Certain species like the witch-hazel and the rhododendron are trees in the South while in the Northern States, owing to less favorable climatic conditions, a shorter growing season, etc., they become bushy. In the same way trees may take on a prostrate form near the timber line on very high mountains. As one climbs a high mountain range the trees get shorter and shorter until finally as the region is approached where tree growth gives way to rocks and everlasting snow the trees found there, like spruces and firs, for instance, cannot raise their heads over several feet above the ground on account of the cold. Each root system nourishes a dense mat of branches which may cover many square feet of surface but which is only a foot or two in height.

The number of shrub species found in all parts of the United States is enormous, there being no less than seven hundred different species in the hawthorn genus alone; so a very large book is needed to describe them all. A very few of the most common are given here and special attention has been paid to the larger and more attractive kinds which are to be found in parks and gardens. Aside from their use in ornamental planting many of the shrubs yield dyes, drugs, etc., and such are being cultivated on a small scale in different parts of the country. The study of shrubs like that of trees yields large returns in the form of added pleasure to walks in the woods and it is hoped that the

few here described and chosen from a very large number will serve to stimulate a lively interest in the smaller woody plants and further study in textbooks specializing in this branch of botany. For convenience the species are grouped as far as possible according to regions.

JUNIPER

JUNIPER *Juniperus communis*
Form Usually a low evergreen shrub growing in large bushy clumps, 8′–10′ across or in pyramidal form 6′–8′ high. Reaches tree size in hill region of Illinois (20′–30′ in height).
Leaves $\frac{1}{3}''$–$\frac{3}{4}''$ long, aw-lshaped. Dark green in summer, becoming a bronze shade in winter.
Fruit A bluish black berry maturing in the third season. Used in the manufacture of certain beverages.
Range Southern Greenland to mountains of Pennsylvania; west to Nebraska; thence south to Texas and Arizona. On Pacific Coast from Alaska to Northern California.

Fig. 43.—Terminal branch, showing leaves, flower, and fruit of juniper.

SPECKLED OR HOARY ALDER

The common alder of the northern alder swamps.

SPECKLED OR HOARY ALDER *Alnus incana*
FORM A bushy shrub 6′–20′ in height composed of many crooked branches.
LEAVES Egg-shaped or oval with pointed tip 2″–4″ long, downy whitish beneath, dark green above. Turn bright yellow in autumn. Edges often doubly notched.
FRUIT A strobile or woody cone bearing the *wingless* seed beneath the scales.
RANGE Along the edge of streams and swamps from Pennsylvania and Nebraska, north to Canada.

Fig. 44.—Leaf, flower, and fruit of speckled alder.

SWEET ELDER

One of the most common shrubs throughout its range. From its fruit a beverage is made; the pith of its hollow stems is used in electrical experiments while the stems themselves furnish the popguns for the boys far from the toy shop.

SWEET ELDER *Sambuccus canadensis*
Form A spreading shrub 5′–15′ high commonly found in thickets by the roadsides or in fence corners. Stems filled with pith, and swollen at the joints.
Leaves Compound, with 5–11 leaflets. Dark green and smooth above, pale green beneath.
Flowers Cream white in color, borne in large flat topped cluster 5″–8″ across. Bloom June to August.
Fruit Berry-like about the size of a pea, dark purple when ripe, borne in clusters. Pleasant taste.
Range Found in thickets throughout the Northern States.

Fig. 45.—Compound leaf, flower, and berries of sweet elder.

THE SUMACS

The sumac family contains about sixteen species found in North America. They all have large pithy twigs and a milky or sometimes sticky juice. Many of them are used extensively in the tanning industry, as they contain considerable tannin and red coloring matter as well. The poison sumac belongs to this group and can be distinguished by its ivory white fruit.

SMOOTH SUMAC

SMOOTH SUMAC *Rhus glabra*
Form A low-growing and spreading shrub 5–15 feet high occasionally reaching tree form.
Leaves Compound, composed of 11–31 leaflets 2″–3½″ long, toothed, pale beneath. Leaf stem and branchlets smooth.
Fruit A fleshy fruit with rather dry flesh surrounding a smooth stone; arranged in cylindrical clusters.
Range New England to Florida, Texas and Missouri.

Fig. 46.—Flowers and compound leaf of smooth sumac.

SERVICE BERRY, SHAD BUSH OR JUNE BERRY

A shrub, or sometimes a tree, from five to forty feet high, taking its name from the fact that it blossoms usually about the time the shad "run." Furnishes the lancewood for the tips of fishing rods.

SERVICE BERRY *Amelanchier canadensis*
FORM Ranges from a shrub a few feet high to a tree 40′ in height and 18″–24″ in diameter.
LEAVES Egg-shaped, 3″–4″ long by 1″–1½″ wide with incurved teeth.
FLOWERS Appear when the leaves are about one-third grown; large white and grouped in long loose clusters at end of the branches.
FRUIT Berry-like, round, purplish and edible. Eagerly eaten by birds.
RANGE Found in the rich upland soils from Maine to Minnesota, south to Kansas and Arkansas.

Fig. 47.—Flowers, leaf, and berries of shad bush.

ROUND-LEAVED DOGWOOD

This genus furnishes some of the most beautiful trees and shrubs in our forests. The tree cornels, notably the flowering dogwood, when in bloom add much charm to the spring season.

ROUND-LEAVED DOGWOOD *Cornus circinata*
Form A shrub 6′–10′ in height.
Leaves Opposite, 2″–6″ long, deeply veined and round; smooth green above, hairy beneath.
Flowers Small and white, grouped in a dense cluster 1½″–3″ across. Bloom in May and June.
Fruit Fleshy pale blue and white in color with round stone. Bitter to the taste, ripens in September.
Range New England to Minnesota. South to Missouri and Virginia.

Fig. 48.—Leaf and flower of round-leaved dogwood.

MOUNTAIN LAUREL

Like the rhododendron the laurel is often used for ornamental planting.

MOUNTAIN LAUREL *Kalmia latifolia*
FORM A dense shrub from 5′–10′ in height in the North, reaching tree size in the Southern Appalachians (up to 35′ tall and 18 inches in diameter).
LEAVES Alternate, thick, glossy, of rubbery texture; remain on branches until second summer. 3″–4″ long, 1–1½″ wide.
FLOWERS Appear in May or June in clusters 4″–5″ across. Individual flowers pink and white, later losing their pinkish tinge. Very showy.
FRUIT A woody capsule ripening in September.
RANGE Maine to Ohio, Florida and Texas. Found in dense thickets in low moist swales.

Fig. 49.—Leaf and flower of mountain laurel.

GREAT LAUREL OR RHODODENDRON

One of the most beautiful of the flowering shrubs. Found only in certain localities in the North but more common in the South. Extensively used for decorative planting.

GREAT LAUREL *Rhododendron maximum*
Form A shrub 15′–20′ tall in Pennsylvania and New York but a bushy tree 30′–40′ high in the Southern Appalachians. May reach a diameter of 10″–12″.
Leaves Thick and stiff, texture something like a rubber plant. 4″–12″ long, 1½″–2½″ wide.
Flower Buds open late June and bloom during early July. Pink and white, very showy.
Range Western New England south through the Appalachians to Northern Georgia. Of the largest size and of best dimensions in the mountains of eastern Tennessee.

Fig. 50.—Leaf and flower of rhododendron.

NEW JERSEY TEA

A shrub from whose leaves tea was brewed during Revolutionary days. The red bark obtained from the roots has been used for medicinal purposes and also furnishes a dull brown dye.

NEW JERSEY TEA *Ceanothus americanus*
FORM A shrub 1′ to 3′ in height.
LEAVES Alternate in arrangement; heart-shaped, smooth, veins deeply depressed.
FLOWERS Bloom in June and July. Borne in small white clusters at the tip of naked flower branches.
FRUIT A dry three-lobed capsule, dark brown.
RANGE Found in dry open woods and pastures from Maine to Florida and Texas.

Fig. 51.—Leaf, flower, and fruit of New Jersey tea.

WITCH-HAZEL

A common shrub throughout the Northern forest but reaching tree size in the Southern Appalachians. It blooms at the time Nature is thinking of winter, as the buds ordinarily burst the latter part of September to early November. From the bark and twigs the extract of witch-hazel is distilled.

WITCH-HAZEL *Hammamelis virginiana*
FORM A shrub in the North; a small tree in the South. From 25′–30′ high, rarely reaching a diameter of 12″–14″.
LEAVES Egg-shaped with narrow ends attached to twigs 4″–6″ long, with wavy edges turning a pale yellow in the autumn.
FRUIT A capsule containing several dark brown seeds ¼″ long which are popped out during the autumn season.
FLOWERS Appearing in autumn borne on short spurs. Golden yellow with delicate fragrance.
RANGE Maine to Minnesota; Georgia to Eastern Texas.

Fig. 52.—Leaf, flower, and fruit of witch-hazel.

WITCH HOBBLE OR HOBBLE-BUSH

A shrub well known to all campers or travelers who frequent the North Woods. Its prostrate habit of branching is responsible for its well-chosen name.

WITCH HOBBLE *Viburnum alnifolium*
FORM A shrub from 3′ to 10′ in height.
LEAVES Heart-shaped from 3″ to 8″ broad; deeply veined and rough in appearance; margin with fine teeth. Turn brilliant red or orange in autumn.
FLOWERS Bloom in May and June. White in color and borne in flat clusters 3″ to 5″ across.
FRUIT Dark red to purple with soft pulp; stone ½″ long.
RANGE Maine to Michigan south to North Carolina.

Fig. 53.—Leaf and flower of witch hobble.

NANNYBERRY

NANNYBERRY *Viburnum lentago*
Form Shrub or sometimes a tree found in the low bottom lands of the Northern States and Canada. Frequently planted for ornamental purposes in parks and gardens.
Leaves Oval, usually with pointed tip and with incurved teeth. In length from $2\frac{1}{2}''$–$3''$ long by $1''$–$1\frac{1}{2}''$ wide; turn an orange red in autumn.
Flowers Small white, appearing in clusters $3''$–$5''$ broad, at the end of the branches (May or June).
Fruit A small dark blue plum-like fruit containing a flat oval stone; sweet and rather juicy.
Range Southwestern Maine to Northern Georgia, Missouri, North Dakota and Wyoming.

Fig. 54.—Leaf, flower, and fruit of nannyberry.

HIGHBUSH BLUEBERRY—SWAMP BLUEBERRY

HIGHBUSH BLUEBERRY *Vaccinium corymbosum*
FORM A shrub 5′–10′ in height, furnishing late blueberries found in the markets.
LEAVES Variable in shape and size. Mostly smooth and inclined to taper toward each end. Margins of leaves plain.
FRUIT Large, black or dark purple in color with slightly acid flavor. Ripen in August and September.
RANGE Found in acid swamps and pastures from Canada to Florida.

Fig. 55.—Leaf and fruit of highbush blueberry.

COMMON BARBERRY

An European species planted widely in this country. Makes a most attractive hedge.

COMMON BARBERRY *Berberis vulgaris*
Form
A thorny bush 3′–10′ high, suckers freely.
Leaves
Are crowded in clusters in the axils of each bunch of spines. Leaves from 1″–1½″ long, pointed at the base with toothed edges.
Flowers
Yellow in color, blossoming in May and June.
Fruit
A brilliant red berry ½″ long, borne in drooping clusters. Berries quite acid.
Range
Originally introduced from Europe, but now grows wild throughout New England and the Northern States.

Fig. 56.—Leaf and fruit of barberry.

HAZEL NUT

Both the common (hazel) and the scientific name were given on account of the resemblance of the husk to a cap or helmet.

HAZEL NUT *Corlyus americana*
Form A bush 3′–6′ high growing in clumps by the roadside or at the forest's edge.
Leaves Alternately arranged, 3″–6″ long, heart-shaped, dark yellowish green above, downy beneath; toothed edges.
Flowers Appear in March or April before the leaves. Catkins 3″–4″ long.
Fruit An oval or oblong nut wrapped in a husk, twice the length of the nut. The wrap is spreading with coarse, toothed edge. Ripens in September. Beaked hazel nut (*Corylus rostrata*) has much longer wrap.
Range Maine to Ontario, south to Florida, west as far as Kansas.

Fig. 57.—Leaf, flower, and fruit of hasel nut.

HAWTHORN

This genus contains altogether seven hundred species, many of which are widely known trees and shrubs extensively used for ornamental planting.

COCKSPUR THORN

COCKSPUR THORN *Cratægus Crus-galli*
Form In reality a tree which may reach a height of 25′–30′ and a diameter of 10″, most often seen as a shrub in hedges or parks.
Leaves Variable in shape, 1″–4″ long, ¼″–1″ wide. Smooth, shiny, dark green above, pale beneath. Edges sharply notched.
Flowers ¾″ in diameter on slender stalks borne in a flat-topped center.
Fruit A fleshy fruit ¾″ in diameter, greenish or dull red, ripening about September and hanging on the branches until midwinter.
Range Southern Canada to Northern Georgia, west to Missouri and Michigan.

Fig. 58.—Leaf, flower, and fruit of cockspur thorn.

BEARBERRY

BEARBERRY *Arctostaphylos uva ursi*
FORM An evergreen shrub from 1'–5' in height. Sometimes assumes prostrate form.
LEAVES Oval with narrower end toward the stem. Outer end frequently notched.
FRUIT A red mealy berry.
RANGE Found in woods and hillsides from Labrador and Alaska to New Jersey, Colorado and Oregon.

Fig. 59.—Leaf and fruit of bearberry.

SAGE BRUSH

This is one of the two score sages which form such an important part of the herbage over wide spaces of the arid West and Southwest. A plant ranging in height from 1-12 feet depending largely upon the amount of moisture available.

SAGE BRUSH *Artemisia tridenta*
Leaves Wedge-shaped, 3–7 toothed or lobed, uppermost leaves narrower. Rather pungent odor.
Flowers Grouped in form of a head.
Range On dry plains from Nebraska and Montana to California and British Columbia.

Fig. 60.—Leaf and flower of sage brush.

BIRCH LEAF OR MOUNTAIN MAHOGANY

BIRCH LEAF *Cercocarpus parvifolius*
Form A slow growing bushy shrub up to 10′ in height; occasionally a tree 15′–20′ tall. Branches and leaves aromatic.
Leaves Thick, smooth and yellowish green above, veins prominent. Coarsely notched above the middle.
Fruit Light chestnut brown tube split at the apex with hairy tail 4″–5″ long projecting from the tubes.
Range Dry mountain ranges of the West. Nebraska to Oregon; Texas to the mountains of lower California.

Fig. 61.—Leaf and flower of birch leaf mahogany.

WESTERN CHOKE CHERRY

WESTERN CHOKE CHERRY
Prunus demissa

Form

In favorable situations taking on tree form 20′ high and 6″ in diameter, otherwise a shrub growing in thickets 4′–10′ high.

Leaves

Thick and leathery, deep dull green, smooth and shiny above, pale beneath. Edges have straight sharp teeth; leaves, twigs and bark when crushed yield strong scent like peach pits.

Flower

White, borne in dense cylindrical clusters.

Fruit

Shiny black cherries $\frac{3}{8}$″–$\frac{1}{2}$″ in diameter in cylindrical clusters. Ripens in early autumn. Sweet but has sharp aftertaste. Used for preserving and greedily eaten by birds.

Range

British Columbia south through mountains of California nearly to Mexican border, east to Western Nebraska and Kansas.

Fig. 62.—Leaf, fruit, and flower of Western choke cherry.

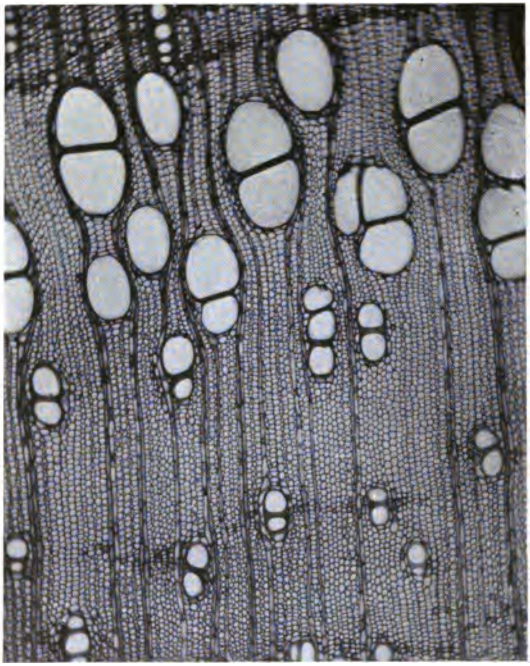
CHAPTER II

HOW TO TELL THE WOODS

MUCH is heard today about the use of substitutes for wood. Concrete ties and telephone poles are to some degree taking the place of the oak, chestnut and white cedar, etc.; furniture is being made from steel and brass, and a wooden bedstead is quite rare in this age of brass and iron. Nevertheless on account of its cheapness and workability wood always will be in demand for certain uses and everyone should be able to recognize the more common kinds of wood from their appearance and structure wherever they may be found.

Of the 40,000,000,000 board feet of timber sawed each year three-fourths comes from the evergreen trees and is therefore considered softwood, for the lumbermen call every kind of wood obtained from an evergreen tree soft, while the boards sawed from broadleaved trees are called hardwoods regardless of the actual hardness. In some cases, however, hardwoods like poplar and basswood are softer than longleaf pine. The extensive use of the softwoods is not alone due to the fact that the supply is more plentiful—of the timber now standing in the United States four-fifths is coniferous—but as a rule such timber is more easily worked and holds its shape better. In all about one hundred and fifty species are used in the lumber trade, but only forty to fifty are extensively used, and of these a few of the more common will be described. When timber is in the log, the bark can be of great assistance in

determining what kind of wood it is but when it is a block or board a sharp knife and a pocket microscope are helpful, as the grain can only be properly judged when sharply cut and in some instances the structure



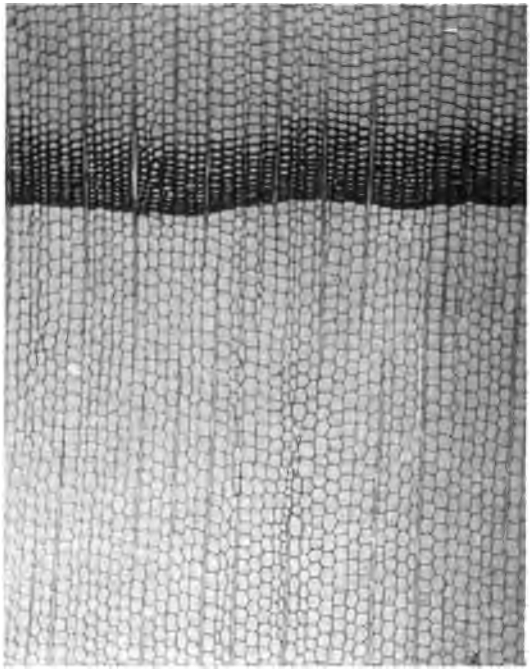
Courtesy H. P. Brown

Fig. 63.—Cross-section of a ring porous wood (white ash), as seen through a microscope. Toward the top of the picture the large pores of the early spring growth and the dense wood of the late summer growth of the preceding year are seen close together.

can only be made out with the aid of a magnifying glass.[1]

[1] For a complete text book on Identification of woods see "Economic Woods of United States," by Samuel J. Record. John Wiley & Sons.

On cutting across a log in addition to the annual growth rings laid on each year by the cambium layer, grayish lines may be seen extending from the heart to bark. These lines, called "medullary rays," are made up



Courtesy H. P. Brown

Fig. 64.—Section of a non-porous coniferous wood (sequoia), seen through a microscope. The dark band marks the late summer growth.

of thin-walled cells like the pith in the center. In some hardwoods, like oak, sycamore and maple, these medullary rays are very broad and conspicuous, especially when cut along the radius—"quarter-sawed"—which shows them off to best advantage. In the softwoods

they are present also but too narrow to be seen with the naked eye. In the conifers there is another peculiarity of structure which is helpful in telling one wood from another—the size and distribution of "resin ducts." These are spaces between the wood cells into which the resin oozes; their presence, size and number assist in separating one softwood from another.

For the purpose of classification all the woods found in the United States may be grouped into two classes:[1]

I. Non-porous woods containing the coniferous varieties or softwoods. In this class the pores are absent and the limit of the annual ring is marked by the denser and usually darker part grown during the summer.

II. Porous woods containing the hardwoods. This class of woods contains more wood elements and the growth rings are marked by the presence of large pores in the early spring growth and the more compact arrangement of the late summer growth—toward the outside of the tree. A cross section of a chestnut log, for instance, shows very clearly the difference between the spring and summer wood.

This class of porous woods is further divided into: (a) Ring porous woods, where the pores in the early wood are large and arranged in a ring or band. Chestnut, oak, hickory and ash belong to this class. (b) Diffuse porous woods. Pores numerous but scattered through the ring. Mahogany is an example of this kind. In some cases the annual ring is made out with difficulty.

[1] The New York State College of Forestry at Syracuse has prepared a collection of the most common woods, thirty-one in number, and a bulletin describing this collection, containing a key for their identification. This collection is sent to the citizens of the State upon receipt of \$.50 for packing, postage, etc.

KEY TO SPECIES[1]

I. NON-POROUS WOODS: CONIFERS: SOFTWOODS

A. Resin ducts, present, both vertical and horizontal.

1. With distinct contrast in color between heart and sapwood.

a. Resin ducts visible to the naked eye, numerous, often well distributed. Wood with characteristic but not always marked resinous odor.

PINE

a1. Little contrast between spring and summer wood; wood soft to medium; moderately resinous; ducts fairly conspicuous, appearing as straw-colored or light-brown lines when block or section is cut with the grain.

WHITE PINE—*Pinus strobus*

a2. Decided contrast between spring and summer wood; latter quite dense. Wood hard, strong and resinous. Color whitish to reddish brown.

YELLOW PINES—*Pinus palustris*
Pinus echinata
Pinus taeda

(Hard to distinguish between these three yellow pines. Longleaf pine, *pinus palustris*, likely to have heaviest wood and narrowest rings. Other two are lighter and yellower in color.

b1. Wood light, rather soft, fairly strong, not highly resinous, growth rings wide and uniform, color light red.

RED PINE—*Pinus resinosa*

[1] Adapted from Toumey, Record and the Structure of the Common Woods of New York by R. P. Prichard, The New York State College of Forestry at Syracuse.

b. Resin ducts mostly conspicuous, not numerous.

b1. Resin ducts very small, mostly invisible to naked eye. Marked contrast in color between heartwood and sapwood. Color, yellowish brown.

TAMARACK—*Larix americana*

b2. Resin ducts somewhat larger, usually visible to naked eye; oval in cross-section. Grain usually straight, sometimes wavy. Color reddish yellow or dark red.

RED FIR—*Pseudotsuga taxifolia*

2. Heartwood and sapwood nearly the same shade.

a. Resin ducts mostly small, scattered and scarcely visible without lens, being of same color as surrounding wood. Wood light, soft and uniform throughout; color white or very light.

RED SPRUCE—*Picea rubens*

B. Resin ducts mostly absent; sometimes present as a result of injury.

1. Heartwood and sapwood of different color.

a. Resin cells numerous, often conspicuous to naked eye.

a1. Odorless and tasteless. Sapwood thin, straw-colored to nearly white, heartwood light cherry. Texture coarse. Resin masses in resin cells prominent; appear (under lens) as rows of black or amber beads, when cells are cut lengthwise.

REDWOOD—*Sequoia sempervirens*

a2. Aromatic odor, little difference in spring and summer wood, sapwood white, heartwood deep reddish brown, occasional flecks of white sapwood found in the heart. Resin cells very numerous, deeply colored, visible under lens, but do not have bead-like appearance.

RED CEDAR—*Juniperus virginiana*

2. Without clear demarkation in color between heartwood and sapwood.
   - *a.* Heartwood little, if any, darker than sapwood.
     - *a*1. Wood harsh and splintery, often knotty and cup shaken, rather close grained. Noticeable contrast between spring and summer wood. Color light brown with slight reddish tinge. Disagreeable odor when wet.

HEMLOCK—*Tsuga canadensis*

     - *a*2. Wood light, soft, weak, growth rings often very wide. Color white or straw-color, occasionally pale brown in old trees.

BALSAM FIR—*Abies balsamea*

   - *b.* Heartwood more deeply colored than sapwood, fading gradually outward.
     - *b*1. Color widely variable, wood variable as to hardness, often "pecky."[1] Smooth surface of sound wood looks and feels greasy. Rays numerous, rather prominent.

BALD CYPRESS—*Taxodium distichum*

     - *b*2. Mild resinous odor, but tasteless. Wood light and soft, color pale brown or reddish; intermingling of lighter and darker shades.

WHITE CEDAR—*Thuja occidentalis*

[1] Pecky means full of small holes caused by fungus disease.

II. POROUS WOODS: BROADLEAF WOODS: HARDWOODS

A. Ring porous wood.

1. Pores in radial lines branching more or less toward the margin of the growth ring.

a. Broad pith or medullary rays absent; rays uniform and inconspicuous. Wood rather light, moderately stiff, but not strong.

*a*1. Pores in spring wood very numerous and in a wide zone. Color brown, odor very mild. Astringent taste.

CHESTNUT—*Castanea dentata*

b. Broad rays present. Wood heavy, hard, strong, characteristic odor.

*b*1. Pores in spring wood in few (1–3) rows, usually not crowded, transition to smaller pores of summer wood abrupt. Large rays often very high on lengthwise section; maximum 5 inches. Abundant tyloses.[1]

WHITE OAK—*Quercus alba*

*b*2. Pores in early wood mostly in several (3–5) rows, crowded; transition to smaller pores in summer wood gradual. Pores in summer wood comparatively large, circular outlines. Large rays, comparatively low, rarely 1 inch high on lengthwise section. Tyloses absent.

RED OAK—*Quercus rubra*

2. Pores in spring wood in a single row or in a zone of 2–3 rows. Pores in summer wood arranged tangentially in conspicuous festoons or concentric bands, usually continuous, wavy, the pores minute or small.

a. Rays rather indistinct. Pores in spring wood large, forming a continuous row. Wood rather light, but hard to split. Texture coarse.

WHITE ELM—*Ulmus americana*

[1] Tyloses are pith-like cells that sometimes fill the pores.

3. Pores in summer wood small, distributed singly, in groups or in mostly short, broken tangential lines.
   a. Odorless, tasteless. Lines of pores in summer wood short, narrow, of few open pores, mostly near the margin of the growth ring. Pores in the spring wood in rather broad zone, numerous. Pith rays uniform, narrow, inconspicuous, almost invisible on cross-section to naked eye.

   WHITE ASH—*Fraxinus americana*

4. Pores in summer wood isolated or fairly evenly distributed; not in groups or lines, comparatively large, often approaching in size those of early wood. Pores in spring wood moderately large, not abundant, usually in very irregular zone. Rays uniform, not conpsicuous, abundant.
   a. Wood heavy, hard, tough, strong; sapwood white; heartwood brown.

   SHAGBARK—*Hicoria ovata*

5. Pith rays fine but distinct.
   a. Very heavy and hard. Heartwood yellowish brown. Tyloses present.

   BLACK LOCUST—*Robinia pseudacacia*

B. Diffuse porous woods.

1. Growth rings absent or indistinct; when present not corresponding to annual periods and not separable into early and late wood.
   a. Broad rays absent. Pores uniform in size, rather large and conspicuous, equally distributed. Rays fine but distinct, producing "silver grain" on radial surface. Color rich reddish brown to light brown.

   MAHOGANY—*Swietenia mahogoni*

2. Growth rings distinct, corresponding to annual periods.
   a. Pores varying in size from large to minute, largest in spring wood approaching ring porous arrangement.
      a1. Heavy and hard; heartwood chocolate brown, sapwood nearly white.

   BLACK WALNUT—*Juglans nigra*

a2. Light and soft. Color of heartwood light reddish brown, sapwood thin and ivory white.

BUTTERNUT—*Juglans cinerea*

b. Pores all minute and indistinct; most numerous in spring wood, causing a lighter colored zone or line appearing sometimes like a ring-porous wood, heartwood reddish; pith rays very fine but very distinct. Wood hard, taking a fine finish.

BLACK CHERRY—*Prunus serotina*

c. Pores minute or indistinct, neither larger nor more numerous in the spring wood; evenly distributed.

c1. Broad pith rays present.

a1. All or most pith rays broad, numerous and crowded, especially tangential sections, medium heavy and hard, difficult to split.

SYCAMORE—*Platananus occidentalis*

b1. Only part of pith rays broad, well defined, quite numerous. Wood reddish white to reddish.

BEECH—*Fagus americana*

c2. No pith rays present.

a1. Wood hard. Color reddish white with dark reddish tinge in outer summer wood.

MAPLE

a2. Most of pith rays broader than the pores and very conspicuous.

HARD OR SUGAR MAPLE—*Acer saccharum*

b2. Pith rays rarely broader than the pores, fine but conspicuous, wood light colored.

SOFT MAPLE—*Acer saccharinum*

*b*1. Wood soft to very soft.

*a*2. Pores crowded, occupying nearly all the space between pith rays.

*a*3. Color yellowish white, often with a greenish tinge in heartwood.

WHITEWOOD—*Liriodendron tulipifera*
or
TULIP

*b*2. Pores not crowded, occupying not over ½ the space between rays; heartwood brownish white to very light brown. Wood light, soft and moderately strong.

BASSWOOD—*Tilia americana*

*c*3. Pith rays scarcely distinct, yet if viewed with ordinary lens, plainly visible as grayish brown specks on the cross-section. Sapwood white, heartwood reddish.

*a*1. Pith rays fairly distinct, the pores rather few and not more abundant in the spring wood.

BIRCH—either
CHERRY BIRCH—*Betula lenta* or
YELLOW BIRCH—*Betula lutea*

APPENDIX

USES OF THE PRINCIPAL AMERICAN SPECIES[1]

Showing also the common and scientific names, distribution and maximum sizes.

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
		CONIFERS	
White or Weymouth pine (*Pinus strobus*)	6 × 250	Maine to Minnesota and along Appalachians to Georgia.	Light, soft and easily worked. Most useful American wood.
Longleaf, Georgia or hard pine (*Pinus palustris*).	3 × 120	Virginia to Texas along coastal plain.	Hard, heavy, strong, durable and resinous, used in construction ties, flooring and general lumber.
Shortleaf or yellow pine (*Pinus ecchinata*).	4 × 120	New York south to Texas, also in Mississippi Valley up to Missouri and Illinois.	Fairly hard, heavy, and strong. Used with longleaf pine for the same purposes.
Cuban or slash pine (*Pinus heterophylla*).	3 × 115	South Carolina to Louisiana along the coast.	Same qualities and uses as longleaf pine.
Loblolly or old field pine (*Pinus taeda*).	5 × 150	From New Jersey along coast to Texas and Arkansas.	Fairly heavy, coarse-grained, fairly durable. Used for general lumber and box boards.
Western yellow or bull pine (*Pinus ponderosa*).	7 × 200	Found in every western mountain State.	Fairly heavy, close-grained, easily worked. Used for lumber, construction timbers, ties, and mine timbers.
Pitch pine (*Pinus rigida*.	3 × 90	Maine to Ohio and Northern Georgia.	Soft, coarse-grained and brittle. Contains some resin. Used for mine props, rough construction work, pulpwood, charcoal, and fuel.
Red or Norway pine (*Pinus resinosa*).	3 × 120	Maine and Minnesota and south to Pennsylvania.	Medium between white and yellow pines in qualities. Used for lumber.
Sugar pine (*Pinus lambertiana*).	12 × 250	South Oregon and along Sierras in California.	Same qualities and uses as white pine.

Measurements are given in feet unless otherwise noted.

[1] Adapted from Moon and Brown—"Elements of Forestry."

USES OF THE PRINCIPAL AMERICAN SPECIES—*Continued*

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
Western white pine (*Pinus monticola*).	8 X 220	British Columbia to California. Chiefly in North Idaho and Western Montana.	Same qualities and uses as white pine.
Lodgepole pine (*Pinus contorta*).	2½ X 100	Alaska to California and Colorado.	Light, soft, weak, brittle, not durable wood. Used locally for ties, mine timbers and general lumber.
Red spruce (*Picea rubens*).	3 X 100	From valley of St. Lawrence south along Appalachians to North Carolina.	Light, soft, close-grained, not durable. Used mostly for paper pulp, sounding boards and dimension timber.
Sitka spruce (*Picea sitchensis*).	16 X 200	Alaska to North California on Pacific Coast.	Light, soft, and straight-grained. Used for lumber, cooperage, boats, pulp, and woodenware.
Englemann spruce (*Picea engelmanni*).	5 X 150	Through Rocky Mountains from Arizona to British Columbia.	Light, soft wood. Used for general lumber for local purposes.
Douglas fir (*Pseudotsuga taxifolia*).	12 X 250	Found in all western mountain States.	Heavy, hard, durable, strong wood. Used for lumber construction, ties, shipbuilding.
Hemlock (*Tsuga canadensis*).	4 X 125	Maine to Minnesota and south on Appalachian Georgia.	Soft, weak, brittle wood. Used for coarse lumber and dimension timbers.
Western hemlock (*Tsuga heterophylla*).	8 X 250	Alaska to California and Montana.	Light, hard, tough, not durable wood. Used for rough lumber and construction timbers.
Tamarack or larch (*Larix americana*).	20 in. X 60 ft.	Newfoundland to Minnesota south to Pennsylvania.	Hard, heavy, strong, and durable. Used for ties, posts, poles, ships, and rough lumber.
Western larch (*Larix occidentalis*.)	8 X 250	British Columbia to Oregon and Montana.	Very hard, heavy, strong, durable and close-grained. Used for ties, construction timbers and lumber.
Balsam fir (*Abies balsamea*).	30 in. X 80 ft.	Newfoundland to Minnesota, south to Virginia.	Light, soft, weak, perishable, coarse-grained. Used for pulp, boxes, and generally sold as spruce.
Amabilis or white fir (*Abies amabilis*).	6 X 250	On Pacific Coast, Oregon to British Columbia.	Light, rather soft and weak. Used for rough lumber, packing cases, etc.
Noble fir or larch (*Abies nobilis*).	8 X 250	On Pacific Coast, Washington to California.	Light, hard, strong wood. Used for lumber, construction and cases.
Red fir (*Abies magnifica*).	10 X 200	Western slopes of the Sierras.	Light, soft, rather weak. Used for lumber, construction and cases.

USES OF THE PRINCIPAL AMERICAN SPECIES—*Continued*

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
Bald cypress (*Taxodium distichum*).	12 ×150	Delaware to Texas along coast and up to Illinois and Indiana.	Light, soft, durable, very workable. Used for ties, posts, cooperage, doors, shingles and inside trim.
Big tree or redwood (*Sequoia washingtoniana*).	35 ×320	Western slopes of the Sierras in California.	Light, soft, durable, weak wood. Used for shingles, grape stakes, ties, and general lumber.
Redwood (*Sequoia sempervirens*).	20 ×350	Northern California coast region.	Same qualities and uses as the big tree.
Western red cedar or giant arborvitæ (*Thuja plicata*).	15 ×200	Alaska to California and Montana.	Light, soft, very durable and brittle. Used for shingles, posts, poles, cooperage and lumber.
Arbor-vitæ or white cedar (*Thuja occidentalis*).	18 in. × 60 ft.	Nova Scotia to Minnesota, south to North Carolina.	Light, soft, brittle, very very durable. Used for shingles, poles, posts.
Incense cedar or white cedar (*Libocedrus decurrens*).	8 ×200	Southern Oregon and California.	Soft, light, weak, brittle. but very durable. Used for shingles, and general lumber.
Port Orford cedar or Lawson's cypress (*Chamaecyparis lawsoniana*)	12 ×200	Along Pacific Coast, Oregon and California.	Light, hard, strong, and durable. Used for flooring, ties, ships, matches, and lumber.
Red cedar (*Juniperus virginiana*).	4 ×100	Found everywhere east of the Rocky Mountains.	Light, soft, and close-grained. Used for pencils cabinets, posts, and chests.

HARDWOODS

Black Walnut (*Juglans nigra*).	6 ×150	New Brunswick to Minnesota and south to the Gulf.	Light, soft, even-grained, seasons well, yields a beautiful polish. Used for furniture, veneers, cabinets, gun-stocks, and fancy hardwood articles.
Butternut or white walnut (*Juglans cinerea*).	4 ×125	New Brunswick to Minnesota and south to Georgia and Arkansas.	Light, soft, coarse-grained. Used as substitute for black walnut.
Chestnut (*Castanea dentata*).	12 ×100	Maine to Michigan south to Mississippi and Georgia.	Light, soft, coarse-grained, durable. Used for ties, poles, posts, mine props and general lumber. Also for tannin.
Beech (*Fagus americana*).	4½ ×120	Nova Scotia to Wisconsin, south to Florida and Texas.	Very hard, heavy, strong and tough, not durable, difficult to season. Used for chairs, handles, woodenware, cooperage, flooring, shoe lasts, etc.

USES OF THE PRINCIPAL AMERICAN SPECIES—*Continued*

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
White elm (*Ulmus americana*).	11 X120	Newfoundland to Rocky Mountains, south to gulf.	Very heavy, hard, tough, cross-grained. Used for implements, hubs, wagon parts, cooperage, handles, etc.
Basswood or linden (*Tilia americana*)	4½ X140	New Brunswick to Minnesota, south to Texas and Georgia.	Light, soft, seasons excellently, even-grained, tough. Used for woodenware, excelsior, cooperage, veneer backing, trunks, and general lumber.
White oak (*Quercus alba*).	4 X100	Maine to Minnesota, south to the Gulf.	Hard, strong, durable, and seasons well. Used for ships, furniture, ties, cooperage, veneers, flooring and cabinet work.

Other oaks classed as white oaks and used for the same purposes are post, burr, rock, swamp white, cow and live oaks. All of these are found in the Eastern and Southern States.

Red oak (*Quercus rubra*).	4 X150	Nova Scotia to Minnesota and south to Georgia and Kansas.	Similar to white oak, but not as hard, strong or as durable. Used for furniture, ties, interior finish and general hardwood lumber.
Black oak(*Quercus velutina*).	4 X100	Maine to Minnesota, Florida and Texas.	Wood is strong, heavy, and hard but not tough. Used for about same purposes as red oak. Its inner bark is rich in tannin and very bitter. It was formerly in great demand as a source of yellow dye. Hence black oak is sometimes known as yellow oak.

(Other oaks classed as black oaks and used for the same purposes are scarlet, pin, Spanish, and water oaks. All are found in the East.

Sugar or hard maple (*Acer saccharum*).	5 X125	Found everywhere east of the prairies.	Hard, heavy, strong, tough but not durable. Used for furniture, cabinets, tools, implements, instruments, and flooring.
Red Maple (*Acer rubrum*).	4 X120	Maine to Minnesota, Florida and Texas.	Wood heavy, close-grained but not strong. Used for furniture, wooden ware, tannery and fuel.
White ash (*Fraxinus americana*).	5 X100	Newfoundland to Minneosta south to Gulf.	Heavy, hard, tough, seasons well. Used for all kinds of implements, furniture, ball bats, handles, vehicles, etc.

USES OF THE PRINCIPAL AMERICAN SPECIES—*Continued*

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
Black Ash (*Fraxinus nigra*).	4 ×90	Maine to North Dakota, south to the mountains of Virginia.	Rather heavy and hard. Used for furniture, interior finish, barrel hoops and splint baskets. The "ash burl" veneer is obtained from this tree.
Shagbark hickory (*Hicoria ovata*).	4 ×125	Maine to Minnesota, south to Gulf.	Very heavy, hard, tough, and strong. Used for ax and tool handles, implements, vehicles, etc.
Pignut Hickory (*Hicoria glabra*).	3 ×75	Maine to Nebraska, Florida and Texas.	Wood heavy, hard and tough. Manufactured into tool handles, agricultural implements and used for fuel.

Two other hickories (*Hicoria alba* and *minima*) are also commonly used and, in general, exhibit the same qualities as the shagbark. All grow in the Eastern and prairie States.

Yellow or red birch (*Betula lutea*).	4 ×100	Newfoundland to Minnesota, south to North Carolina.	Heavy, very strong and hard and close-grained. Used for furniture, hubs, handles, flooring, veneer, and interior finish.
Canoe or paper birch (*Betula papyrifera*).	3 ×120	New England and Eastern Canada to Pennsylvania; Ohio and west to Idaho and Alaska.	Pinkish white bark formerly used by the Indians for canoes, now made into fancy articles. The wood which is heavy, hard, white, furnishes stock for spools, bobbins, shoe pegs, wooden ware, etc.
Yellow poplar or tulip (*Liriodendron tulipifera*).	10 ×200	Vermont to Florida, west to Michigan and Arkansas.	Light, soft, even texture, seasons well, not very durable. Used for interior finish, boats, woodenware and general hardwood lumber.
Red gum or sweet gum (*Liquidambar styraciflua*).	5½ ×150	Connecticut to Florida, west to Missouri and Texas.	Fairly heavy, satiny, difficult to season, cross-grained. Used mostly for veneers, cooperage, furniture, interior finish.
Black or yellow locust (*Robinia pseudacacia*).	3½ ×90	Pennsylvnaia to Georgia, west to Minnesota and Oklahoma.	Very hard, heavy, strong and durable. Used for ships, insulator pins, wagon stock, posts and certain specialized uses.
Sycamore or plane (*Platanus occidentalis*).	12 ×170	Found in every State east of the central Prairies.	Heavy, hard, not durable, cross-grained. Used for furniture, butcher blocks and small wooden articles and woodenware.

USES OF THE PRINCIPAL AMERICAN SPECIES—*Continued*

Common and Scientific Names.	Maximum Diameter and Height.	Distribution.	Qualities and Uses.
Black or red cherry (*Prunus serotina*)	5 × 110	Same distribution as sycamore.	Strong, hard, close-grained, satiny, very durable, excellent cabinet wood. Used for fine furniture, interior finish, instruments, cases, clocks, etc.
Cottonwood (*Populus deltoides*).	8 × 100	Found in every State east of the Rocky Mountains.	Soft, light, weak, cross-grained. Used for crates and boxes, cooperage and cheap lumber.
Swamp cottonwood or cottonwood (*Populus heterophylla*).	3 × 130	Connecticut to Georgia west to Arkansas. Found mostly in South.	Soft, light, even, straight-grained. Seasons well. Used for general lumber purposes, boxes, and crating, veneers and cooperage.

VOLUME TABLE, IN BOARD FEET, FOR WHITE PINE IN MASSACHUSETTS

Courtesy of Massachusetts State Forester

Diameter, Breast-high (inches).	Total Height (feet).						
	30	40	50	60	70	80	90
	Contents in Board Feet						
5	10	—	—	—	—	—	—
6	15	20	30	—	—	—	—
7	20	30	40	50	65	—	—
8	25	35	50	65	85	—	—
9	30	45	60	80	105	115	—
10	—	55	75	95	125	145	—
11	—	65	90	115	145	170	200
12	—	75	105	135	165	200	230
13	—	90	120	155	190	235	260
14	—	—	135	175	215	265	300
15	—	—	155	195	245	300	340
16	—	—	175	215	270	335	380
17	—	—	—	240	300	370	420
18	—	—	—	260	325	405	465
19	—	—	—	280	355	445	510
20	—	—	—	305	385	485	555
21	—	—	—	—	420	525	605
22	—	—	—	—	450	570	650
23	—	—	—	—	480	620	700
24	—	—	—	—	515	665	750
25	—	—	—	—	550	715	800
26	—	—	—	—	—	—	855
27	—	—	—	—	—	—	905

Note.—To estimate the contents of a piece of timberland the forester measures a certain percentage (the smaller the tract the larger the percentage must be) of the trees with a pair of calipers. The trees are always measured outside the bark at a distance of approximately 4½ feet from the ground. The quantity of each kind of timber is then computed by means of a volume table which shows the contents (board feet, cubic feet, market, etc.) of standing trees of different sizes. By multiplying the number of trees of each size and species by the figures obtained from the volume tables, the quantity of timber actually measured is found. If ten per cent of the trees have been measured multiplying this amount by ten will give the volume on the entire tract.

THE VOLUME TABLE GIVES VALUES ONLY FOR THE SPECIES FOR WHICH IT WAS MADE, e.g., a pine volume table *can not* be used for white oak.

DOYLE LOG RULE

Diameter of log in inches (at small end inside bark).	Log Length in Feet				
	8	10	12	14	16
	Contents in Board Feet.				
6	2.0	2.5	3.0	3.5	4.0
7	4.5	5.6	6.8	7.9	9.0
8	8	10	12	14	16
9	12	16	19	22	25
10	18	23	27	32	36
11	24	31	37	43	49
12	32	40	48	56	64
13	40	50	61	71	81
14	50	62	75	88	100
15	60	75	91	106	121
16	72	90	108	126	144
17	84	106	127	148	169
18	98	122	147	171	196
19	112	141	169	197	225
20	128	160	192	224	256
21	144	181	217	253	289
22	162	202	243	283	324
23	180	226	271	313	359
24	200	250	300	350	400
25	220	276	331	386	441
26	242	302	363	423	484
27	264	330	397	463	530
28	288	360	432	504	576
29	312	391	469	547	625
30	338	422	507	591	676
31	364	456	547	638	729
32	392	490	588	686	784
33	420	526	631	736	841
34	450	562	675	787	900
35	480	601	721	841	961
36	512	640	768	896	1024

Note.—In the United States and Canada there are many log rules in actual use; many of these, however, are of purely local importance. These rules are intended to give the contents in board feet or other units of logs of different diameters and lengths. Ordinarily logs are measured in the woods by the scaler, who uses a three-foot hickory rule upon which the figures given in the log rule are burned. He measures the log at the small end inside the bark, estimates the log length in even feet by his eye, reads from the figures on the scale stick the contents of a log of that size and records the amounts in a note book.

LIST OF REFERENCE BOOKS ON FORESTRY

General Forestry

Fernow, Dr. B. E. Economics of Forestry.
——— History of Forestry.
Hawley and Hawes. Forestry in New England.
Moon and Brown. Elements of Forestry.
Pinchot, Gifford. Primer of Forestry.
——— The Training of a Forester.
Roth, Prof. Filibert. First Book of Forestry.

Dendrology (Forest Botany)

Blakeslee and Jarvis. Trees in Winter.
Britton, Dr. N. L. North American Trees.
Hough, Romeyn B. A Handbook of the Trees of the Northern States and Canada.
Keeler, Harriet L. Our Native Trees.
——— Our Northern Shrubs.
Otis, C. H. Michigan Trees.
Sargent, Prof. Charles S. Manual of the Trees of North America.
Sudworth, Geo. B. Forest Trees of the Pacific Slope (Forest Service Bulletin.)

Animal Life in the Forest

Forbush, E. H. Useful Birds and Their Protection.
Heisemann, M. How to Attract and Protect Wild Birds.
Hornaday, W. T. Our Vanishing Wild Life.
Seton, Ernest Thompson. Life History of Northern Animals.

Applied Forestry

Graves, Prof. Henry S. Forest Mensuration.
——— Principles of Handling Woodlands.
Record, Prof. Samuel J. Economic Woods of the United States.

City Forestry and Landscape Gardening

Peets, Elbert. Practical Tree Repair.
Solotaroff Wm. Shade Trees in Towns and Cities.
Van Rensselaer, Mrs. Schuyler. Art Out of Doors.
Waugh, Prof. F. A. Landscape Gardening.

Camp Life and Woodcraft

Hanks, C. S. Camp Kits and Camp Life.
Kephart, Horace. Book of Camping and Woodcraft.

Conservation

Hornaday, W. T. Wild Life Conservation.
Pinchot, Gifford. The Fight for Conservation.
Price, Overton W. The Land We Live in.
Van Hise, Charles R. Conservation of Our Natural Resources.

Stories Dealing with Forestry and the Woods

Lawson, W. P. Log of a Timber Cruiser.
Wheeler, F. R. Boy with the U. S. Foresters.
White, Stewart Edward. The Blazed Trail.
——— The Riverman.
——— The Rules of the Game.

DEFINITION OF TERMS USED IN FORESTRY AND LOGGING

Taken from Bulletin 61, U. S. Forest Service

Accretion. Increase in diameter or height; distinguished from *increment,* increase in volume.

Advance Growth. Young trees which have sprung up in accidental openings in the forest or under the forest cover before reproduction cuttings are begun.

After Growth. Young trees which have sprung up as the result of reproduction cuttings.

Angle Mirror. An instrument for turning angles in subdividing land.

Annual Ring. The layer of wood produced by the diameter growth of a tree in one year, as seen on a cross section.

Arboriculture. The growing of trees for any purpose.

Aspect. The direction toward which a slope faces. The eight main points of the compass, N., N.E., E., S.E., S., S.W., W., N.W. are distinguished in forest description.

Assimilation. In plants the production of organic matter from inorganic matter.

Back Fire. A fire started purposely some distance ahead of a fire which is to be fought. The back fire is intended to burn against the wind, so that when the two fires meet, both must go out for lack of fuel.

Ball Planting. A method of transplanting young trees with balls or lumps of earth around the roots.

Basal Area. The area of a cross-section of a tree, or the sum of such areas.

Barn Boss. One who has charge of the stables in a logging camp.

Birl. To cause a floating log to rotate rapidly by treading upon it.

Blank. An opening in the forest where, from any cause, very few or no trees are growing.

Blaze. To mark, by cutting into trees, the course of a boundary, road, trail, etc.

Board Foot. The contents of a board one foot square and one inch thick. The common unit of measure for logs and lumber in the United States.

Board Measure. The standard of lumber measurement, the unit of which is the board foot.

Board Rule. A graduated stick for determining the contents of boards. The number of board feet in boards of given widths and lengths is shown upon the stick. Often called scale stick.

Body Wood. Cord wood cut from those portions of the stems of trees which are clear of branches.

Boom. Logs or timbers fastened together end to end to hold floating logs. The term sometimes includes the logs inclosed, as a "boom of logs".

Boom Company. A corporation engaged in handling floating logs and owning booms and booming privileges.

Breasthigh. At or having a height of 4½ feet above the ground. The forester usually calipers trees at this point.

Broad-leaved Trees. Applies to trees whose leaves have a broad flat surface unlike the needle or awl-shaped leaves of the conifers.

Buck. To saw felled trees into logs.

Bull Chain. A very heavy chain, to which a number of short chains, with hooks on one end and dogs on the other, are attached. It is used to draw logs from the millpond up the gangway.

Bull Donkey. A large donkey engine which, by drum and cable, drags logs from the place where they are yarded to a landing.

Bummer. A small truck with two low wheels and a long pole, used in skidding logs.

Bunch Logs, To. To collect logs in one place for loading.

Bunk. 1. The heavy timber upon which the logs rest on a logging sled. 2. The cross beam on a log car or truck, on which the logs rest. 3. A log car or truck. 4. A bed in a logging camp.

Burn. An area over which fire has run to the noticeable injury of the forest.

Butt Off, To. 1. To cut a piece from the end of a log on account of a defect. 2. To square the end of a log.

Caliper. An instrument for measuring the diameter of trees or logs, usually consisting of a graduated beam to which is attached one fixed and one sliding arm.

Cambium. In trees and shrubs, the layer between the bark and wood, producing the annual ring.

Cant Hook. A tool like a peavey, but having a toe ring and lip at the end instead of a spike.

Catamaran. A small raft carrying a windlass and grapple, used to recover sunken logs.

Catface. A partly healed over fire scar on the stem of a tree.

Clean Cutting. 1. The cutting of the entire stand. 2. An area upon which the entire stand has been cut.

Cleaning. A thinning made in a stand which has not reached the small-pole stage. Its main object is to remove trees of undesirable form and species.

Clear Length. That portion of the stem of a tree free from branches.

Compartment. The unit of area treated in the working plan. The size and the shape of compartments are determined mainly by topographic features.

Composite Forest. A forest in which both seedlings and sprouts occur in considerable number. It may be either pure or mixed.

Conifer. A member of the Pine Family or Coniferæ.

Conservative Lumbering. Practical forestry; any method of lumbering which perpetuates the forest by use.

Cookee. Assistant cook and dishwasher in a logging camp.
Coppice. A forest grown from sprouts.
Crown. The upper part of a tree, including the living branches with their foliage.
Crown Density. The density of the crowns of the trees in a forest. It is usually measured by the extent to which the ground is shaded, and expressed as a decimal, .4 or .7, etc.
Cruise. To estimate the amount and value of standing timber.
Cruiser. One who makes a business of cruising timber. Sometimes called a "land looker."
Culled Forest. Forest from which cuttings by selection have removed a portion of the trees.
Cut. A season's output of logs.
Cut Over, To. To cut most or all of the merchantable timber in a forest.
Cut-over Forest. Forest in which most or all of the merchantable timber has been cut.
Cutting. A piece of a leaf, stem, or root which when inserted in moist material is capable of sending out roots and forming a new plant; a slip.
Cutting Area. The area over which cuttings are to be or have been made.
Deadhead. A sunken or partly sunken log.
Diameter, Breasthigh. The diameter of a tree at 4½ feet above the ground.
Diameter Class. All trees in a stand whose diameters are within prescribed limits.
Diameter Growth. The increase in diameter of a tree.
Diameter Tape. A tape for ascertaining the diameter of trees, so graduated that the diameter, corresponding to the girth of a tree, is read directly from the tape.
Dibble. A tool for making holes for planting seeds or young trees.
Diœcious. Male and female flowers borne on different plants.
Dominant. Having the crown free to light on all sides because of greater height.
Doty. Decayed.
Drive. A body of logs or timber in process of being floated from the forest to the mill or shipping point.
Dry Topped. Having a dead or a partially defoliated crown, or discolored foliage, as the result of injury or disease.
Duffle. The personal belongings of a woodsman or lumberjack which he takes into the woods.
Fail Spot. A place where natural or artificial reproduction has failed.
False Ring. The layer of wood, less than a full season's growth, and seldom extending around the stem, which is formed whenever the diameter growth of a tree is interrupted and begins again during the same growing season.
Filer. One who files the crosscut saws in the woods.
Final Yield. All material derived from reproduction cuttings or clean cuttings. It is usually the chief crop, and marks the end of the rotation.

Firebreak or *Fireline*. An opening, plowed strip of land or anything which prevents the spread of fires in the forest.

First Growth. 1. Natural forest in which no cuttings have been made. 2. Trees grown before lumbering or severe fire entered the forest; belonging to the original stand.

Flume. An inclined trough in which water runs, used in transporting logs or timbers.

Forest. An area whose principal crop is trees. A forest includes both the forest cover and the soil beneath it. A forest judged by the character of the stand may be timber land or wood land. These constitute the two great classes of forest, between which it is possible to draw a practical but not an absolute distinction. Timberland may be broadly defined as that class of forest which contains in commercial quantities trees of sufficient size and of the required kind to furnish saw logs, wood pulp, ties, poles or wood for similar uses.

Forest Capital. The capital which a forest represents. It consists of the forest land, or fixed capital, and the stand of trees.

Forester. One who practices forestry as a profession.

Forest Cover. All trees and other plants in a forest.

Forest Fire. A fire in timberland or woodland. A forest fire may be a ground fire, a surface fire, or a crown fire. A ground fire is one which burns in the forest floor and does not appear above the ground. When a fire runs over the surface or burns the undergrowth it is a surface fire. When a surface fire spreads from the undergrowth to the crowns, it becomes a crown fire.

Forest Floor. The deposit of vegetable matter on the ground in a forest. Litter includes the upper, but slightly decomposed portion of the forest floor; humus, the portion in which decomposition is well advanced.

Forest Influences. All effects resulting from the presence of the forest, upon health, climate (including wind, rainfall, temperature, etc.), stream flow, and economic conditions.

Forest Management. The practical application of the principles of forestry to a forest area. Forest management includes: forest mensuration or the determination of the present and future product of the forest; forest organization, or the preparation of working plans and planting plans, detailed and comprehensive schemes for the establishment and best use of the forest; and forest finance, or the determination of the money returns from forestry.

Forest Nursery. An area upon which young trees are grown for forest planting.

Forest Plantation. Forest growth, established by setting out young trees or by sowing seed. A forest plantation, made by setting out young trees, which has passed the small-pole stage, is called a planted forest. A sown forest plantation which has passed the small-pole stage is called a sown forest.

Forest Policy. The principles which govern the administration of the forest for its best permanent use.

Forest Products. All usable material yielded by the forest. The following classes are distinguished: major products include all

wood harvested for any purpose; minor products include all forest products except wood.

Forest Protection. The safeguarding of the forest against any damage caused by its own growth.

Forestry. The raising (and utilization) of repeated crops of timber from non-agricultural soils. The main branches of forestry are forest policy, silviculture, forest management, forest protection and forest utilization.

Forest Type. A forest or a part of a forest possessing distinctive characteristics of composition or habit of growth.

Forest Utilization. The most profitable use of forest products, including lumbering, the various wood-using industries such as the wood pulp, wood tannin, cooperage, veneer, excelsior, and similar industries and the uses to which our woods are put.

Form Factor. The ratio, expressed decimally, between the volume of a tree, or portion of a tree, and of a cylinder or the same height and diameter.

Germination. The process by which a seed or spore gives rise to a new and independent plant.

Girdling. The act of cutting through the inner bark and sapwood to cut off the circulation of the sap. Practiced in the Southern Appalachians as a means of quickly clearing agricultural land.

Ground Cover. All small plants growing in a forest, except young trees; such as ferns, mosses, grasses and weeds.

Hardwood. A broadleafed, or dicotyledonous, tree.

Haul. In logging, the distance and route over which teams must go between two given points, as between the yard or skidway and the landing.

Head Driver. An expert river driver who during the drive is stationed at a point where a jam is feared. Head drivers usually work in pairs.

Head Faller. The chief of a crew of fallers.

Heel In, To. To store young trees for planting by laying them against the side of a trench and covering the roots with earth.

Height Growth. The increase in heights of trees.

Height Measure. An instrument for measuring the height of a tree.

Humus. Decomposed organic matter in and on the surface of the soil.

Hypsometer. An instrument for taking heights of trees.

Ice a Road, To. To sprinkle water on a logging road so that a coating of ice may form, thus facilitating the hauling of logs.

Improvement Thinning. Usually the first thinning made when a forest is put under management, to prepare it for the application of a regular system.

Increment. The volume or value of wood produced during a given period by the growth of a tree or of a stand. Three kinds of increment are distinguished: Volume increment is the increase in volume of a tree or stand; quality increment is the increase in value per unit of volume; price increment is the increase resulting from an increase in the price of forest products independent of quality increment.

Index Forest. That forest which in density, volume, and increment reaches the highest average which has been found upon a given locality. Measurements of such a forest provide a standard for comparison with other forests of the same age and composition, grown under similar conditions.

Intermediate. A tree class having the crowns shaded on the sides, but free to light at the top.

Intolerant. Incapable of enduring heavy shade.

Jack Chain. An endless spiked chain, which moves logs from one point to another, usually from the mill pond up an incline to the sawmill.

Jam. A stoppage or congestion of logs in a stream, due to an obstruction or to low water.

Key Log. In river driving, a log which is so caught or wedged that a jam is formed and held.

Landing. A place to which logs are hauled or skidded preparatory to transportation by water or rail. A rough and tumble landing is one in which no attempt is made to pile logs regularly.

Layer. A shoot which, while attached to the plant, takes root at one or more places and forms a new plant.

Lift. To pry up seedlings from the seedbed so that they may be pulled by hand for transplanting.

Litter. That portion of the forest floor which is not in an advanced state of decomposition.

Loam. Friable, mellow, rich soil containing much humus.

Locality. An area, considered with reference to forest-producing power; the factors of the locality are the altitude, soil, slope, aspect and other local conditions influencing forest growth.

Log, To. To cut logs and deliver them at a place from which they can be transported by water or rail, or, less frequently, at the mill.

Log Rule. 1. A tabular statement of the amount of lumber which can be sawed from logs of given lengths and diameters. 2. A graduated stick for measuring the diameter of logs. The number of board feet in logs of a given diameter and length is shown upon the stick.

Logging Sled. The heavy double sled used to haul logs from the skidway or yard to the landing.

Lumber. To log, or to manufacture logs into lumber, or both.

Lumberjack. One who works in a logging camp.

Many-aged Forest. A forest through all parts of which many different age classes of trees tend to distribute themselves. When all age classes are thus distributed, the forest is all aged.

Market. A unit of measurement used in northern New York; a log 19 inches in diameter at the small end and 13 feet long.

Marking Hatchet. A hatchet for marking trees. A raised die is cut on the head for stamping the face of the blaze.

Mature Forest. Forest so old that growth in height is practically at an end, and diameter growth is decreasing.

Mean Annual Increment. The total volume of a tree or stand divided by its age in years.

Merchantable Length. The total length of that portion of the stem which can be used under given conditions.

Merchantable Volume. The total volume of that portion of the tree which can be used under given conditions.

Mixed Forest. Forest composed of two or more species.

Monœcious. Both male and female flowers borne on the same plant (e.g., black walnut.)

Mulch. Any loose material that protects the soil from frost or evaporation.

Muskeg. A term commonly applied to sphagnum swamps by the Indians and woodsmen of the Northern States.

National Forest. A forest which is the property of the United States. In addition to recreation features, timber is sold from the National Forests, grazing is allowed, as well as agricultural settlement.

National Park. A tract of Government land withdrawn by special act of Congress from settlement, occupancy or sale, under the laws of the United States, for the benefit and enjoyment of the people.

Nurse. A tree which fosters the growth of another in youth.

Nursery. An establishment for the raising of plants.

Overmature Forest. Forest in which, as the result of age, growth has almost entirely ceased, and decay and deterioration have begun.

Parasite. A plant or animal that lives upon and obtains its food from other living plants or animals.

Patch Sowing. Sowing forest seed in spots.

Pecky. A term applied to an unsoundness; most common in bald cypress.

Pike Pole. A piked pole, 12 to 20 feet long, used in river driving.

Pitch Pocket. A cavity in wood filled with resin.

Planting Site. An area which is to be artificially stocked with forest growth.

Pole. A tree from 4 to 12 inches in diameter, breasthigh. A small pole is a tree from 4 to 8 inches, breasthigh. A large pole is a tree from 8 to 12 inches in diameter, breasthigh.

Pollard. To invite the production of shoots at the top of a tree by cutting back the crown.

Present Yield. The amount of wood at present contained in given trees upon a given area.

Protection Forest. A forest whose chief value is to regulate stream flow, prevent erosion, hold shifting sand or exert any other indirect beneficial effect.

Pruning. The removal of branches from standing trees by natural or artificial means. The clearing of the stem through the death and fall of branches for want of light is known as natural pruning. When living branches are removed by cutting them close to the stem the operation is known as green pruning; when it is confined to dead branches, as dry pruning.

Puddle. To dip the roots of young trees in thin mud. Before heeling trees in the trench on a planting site their roots are usually "puddled."

Pure Forest. Forest composed of trees of one species. In practice, a forest in which 80 per cent of the trees are of one species.

Quarter Sawing. Originally meant sawing along the radius of a log to expose the medullary rays and add to the beauty of the

figure of the wood. In actual practice there are several ways of accomplishing this result.

Regular Forest. Forest in which the trees are approximately of the same age.

Reproduction. 1. The process by which a forest is renewed. Natural reproduction is the renewal of a forest by self-sown seeds, or by sprouts. Artificial reproduction is the renewal of a forest by sowing or planting. 2. Seedlings or saplings from sprouts or from self-sown seed.

Reproduction Cutting. Any cutting intended to invite or assist reproduction.

Rise. The difference in diameter, or taper, between two points in a log.

River Boss. The foreman in charge of a log drive.

Root. A part of the plant which absorbs nourishment for the plant, or serves as a support.

Root Collar. That place at the base of a tree where the swelling which is the direct result of the ramifications of the roots begins.

Rotation. The period represented by the age of a forest, or a part of a forest, at the time when it is cut, or intended to be cut.

Sample Tree. A tree which in diameter, height and volume is representative of a tree class. A class sample tree is a tree which in diameter, height and volume represents the average of several tree classes.

Sapling. A tree 3 feet or over in height, and less than 4 inches in diameter, breasthigh. A small sapling is a sapling from 3 to 10 feet in height. A large sapling is a sapling 10 feet or over in height.

Scaler. One who determines the volume in logs by applying the scale stick to the small end of the log and reading the contents from the stick.

Second Growth. Forest growth which comes up naturally after cutting, fire or other disturbing cause.

Seed. The ripened ovule.

Seedbed. A specially prepared area, usually in the forest nursery, for the raising of seedlings.

Seed Forest. A forest composed wholly or mainly of trees from seed.

Seed Spot. A small area, usually in a burn or in an opening in the forest, which is sown with tree seed.

Seed Tree. Any tree which bears seed; specifically, a tree which is left to provide the seed for natural reproduction.

Seed Year. A year in which a given species of tree bears seed; specifically, a year in which a given species bears seed abundantly.

Self-sown Seed. Strictly, disseminated without the intervention of human or animal agency; in common practice, seed sown by any agency other than man.

Shake. A crack in timber, due to frost or wind.

Shelterbelt. Natural or artificial forest maintained as a protection from wind or snow. A narrow shelterbelt in which true forest conditions do not exist is a windbreak when maintained as

a protection against wind, and a snowbreak when maintained as a protection against snow.

Shrub. A woody plant with no main stem or trunk.

Silvics. The science which treats of the life of trees in the forest.

Silviculture. The art of producing and tending a forest; the application of the knowledge of silvics in the treatment of a forest.

Skid. 1. To draw logs from the stump to the skidway, landing, or mill. 2. As applied to a road, to re-enforce by placing logs or poles across it.

Skid Road. 1. A road or trail leading from the stump to the skidway or landing. 2. A road over which logs are dragged, having heavy transverse skids partially sunk in the ground, usually at intervals of about 5 feet.

Slash. 1. The debris left after logging, wood or fire. 2. Forest land which has been logged off and upon which the limbs and tops remain, or which is deep in debris as the result of fire or wind.

Slide. A trough built of logs or timber, used to transport logs down a slope.

Snowbreak. 1. The breaking of trees by snow. 2. An area on which trees have been broken by snow.

Snub. To check, usually by means of a snub line, the speed of logging sleds or logs on steep slopes, or of a log raft.

Soil. In forest description the origin, composition, depth and moisture if the forest soil are considered under soil.

Species. A division of a genus, the plants of which seem to be derived from an immediate common anscestor.

Splash Dam. A dam built to store a head of water for driving logs.

Spring Board. A short board, shod at one end with an iron calk, which is inserted in a notch cut in a tree, on which the feller stands while felling the tree.

Sprinkler. A large wooden tank from which water is sprinkled over logging roads during freezing weather in order to ice the surface.

Sprout. A tree which has grown from a stump or root. A shoot is a sprout which has not teached a height of 3 feet.

Sprout Forest. A forest consisting wholly or mainly of sprouts.

Sprout Method. That method of conservative lumbering in which reproduction is obtained by sprouts.

Spud. A tool for removing bark.

Stand. All growing trees in a forest or in part of a forest.

Standard. A tree from 1 to 2 feet in diameter, breasthigh.

Stand Table. A tabular statement of the number of trees of each species and diameter class upon a given area.

Stem. The trunk of a tree. The stem may extend to the top of the tree, as in some conifers, or it may be lost in the ramification of the crown, as in most broadleaf trees. In tree description the stem is described as long or short, straight or crooked, cylindrical or tapering, smooth or knotty.

Storage Boom. A strong boom used to hold logs in storage at a sawmill.

Stratify. To preserve tree seeds by spreading them in layers alternating with layers of earth or sand.

Strip Method. The method of conservative lumbering in which reproduction is secured on clean-cut strips by self-sown seed from the adjoining forest.

Stump. That portion of the tree below the cut made in felling a tree.

Stumpage. The value of timber as it stands uncut in the woods; or, in a general sense, the standing timber itself.

Sucker. A shoot from an underground root or stem.

Sun Scald. An injury to the cambium caused by sudden exposure of a tree to strong sunlight.

Suppressed. Having growth more or less seriously retarded by shade.

Swamp. To clear the ground of underbrush, fallen trees and other obstructions preparatory to constructing a logging road or opening out a gutter road.

Swell Butted. As applied to a tree, greatly enlarged at the base.

Tally Man. One who records or tallies the measurements of logs as they are called by the scaler.

Tangential Sawing. The common way of cutting logs by which boards on each side of the center board are sawed by a cut that is tangent to the annual rings. This method serves to bring out the grain of wood most conspicuously.

Tap-root. A central root running deep into the soil.

Thinning. The removal of a portion of the trees with the object of improving the stand without inviting natural reproduction. The following kinds of thinnings are distinguished: cleaning, improvement thinning, accretion thinning.

Tolerance. The capacity of a tree to endure shade.

Tote. To haul supplies to a logging camp.

Transpiration. The process by which water is taken up by the roots of plants and given off to the air through the leaves and branches.

Trap Tree. A tree deadened or felled at a time when destructive bark beetles will be attracted to it and enter the bark, which is then peeled from the tree and exposed to the sun, burned or buried, as the case may require, to destroy the insect.

Tree. A perennial woody plant with a single stem which from natural tendencies does not divide into branches for some distance above the ground.

Tree Analysis. A series of measurements and observations upon a felled tree to determine its growth and life history.

Tree Class. All trees of approximately the same size. The following tree classes are distinguished: seedling, shoot, small sapling, large sapling, small pole, large pole, standard, veteran.

Tree Crown. That part of a tree that is branched, forming a head.

Turkey. A bag containing a lumberjack's outfit. To "histe the turkey" is to take one's personal belongings and leave camp.

Two-storied Forest. Comprising on the same area two classes,

which vary considerably in height, composed of trees of differetn species.

Underbrush. All large, woody plants, such as witch hobble, laurel, striped maple and devil's club, which grow in a forest, but have no main stem or trunk.

Undergrowth. The ground cover, underbrush, and young trees below the large sapling stage.

Undercut. The notch cut in a tree to determine the direction in which the tree is to fall, and to prevent splitting.

Underplant. To plant trees under an existing stand.

Used Length. The sum of the lengths of logs cut from a tree.

Valuation Survey. The measurement or other detailed study of the stand upon a valuation or experiment area. Two kinds of valuation survey are distinguished: 1. The strip survey comprises the measurement of a stand, or a given portion of it upon strips usually 1 chain wide. 2. The plot survey comprises the measurement of the stand, or a given portion of it, upon isolated plots not in the form of strips.

Veteran. A tree over 2 feet in diameter, breasthigh.

Volume. Amount or mass of a tree or stand.

Volume Table. A tabular statement of the volume of trees in board feet or other units upon the basis of their diameter breasthigh, their diameter breasthigh and height, their age, or their age and height.

Volunteer Growth. Young trees which have sprung up in the open, as white pine in old fields, or cherry and aspen in burns.

Wanigan. A houseboat used as sleeping quarters or as kitchen and dining-room by river drivers.

Weed Tree. A tree of a species which has little or no value.

White Water Man. A log driver who is expert in breaking jams on rapids or falls.

Windbreak. 1. The breaking of trees by wind. 2. A belt of trees which serves as a protection from wind.

Windfall. 1. A tree thrown by wind. 2. An area on which trees have been thrown by wind.

Wind-firm. Able to withstand heavy wind.

Work. To harvest the final yield under a working plan.

Working Plan. A detailed and comprehensive scheme for the best permanent use of a forest.

Yarding Donkey. A donkey engine mounted upon a heavy sled, used in yarding logs by drum and cable.

Yield. The amount of wood at present upon, or which after a given period will be upon, a given area.

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